PUBLICATION 363

1992-1993

VEGETABLE Production Recommendations

Ministry of Agriculture and Food

Ontario

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, all pesticides listed in this publication were federally registered, reviewed by the Ontario Pesticides Advisory Committee and classified by the Ministry of the Environment as of November 6, 1991.

Regulation 751 under the Pesticides Act requires that pesticides be used in accordance with the product label and in accordance with the Regulation. The information contained in this publication is general information only and is subject to the specific information and recommended uses listed on the pesticide container label and the provisions of Regulation 751.

PAY CLOSE ATTENTION TO ALL INSTRUCTIONS AND WARNINGS PRINTED ON THE PESTICIDE LABEL.

The Ministry of Agriculture and Food, or the Ontario Crop Protection Committee by printing this publication does not offer any warranty or guarantee and they do not assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

POLICY STATEMENT

In this Publication, most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the more toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that, in some cases, the most effective pesticides are highly toxic.

Weather and other factors influence the effectiveness of pesticides and the likelihood of plant injury by control chemicals. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluble powders (WP or SP) generally are less likely to cause plant injury than liquid concentrates (EC, SC, and F).

A number of brand names of pesticides are given in the calendars as a convenience to the grower and are neither an endorsement of the product nor a suggestion that similar products are not effective.

The pesticide recommendations are reviewed annually by the Ontario Crop Protection Committee. For additional information or clarification of recommendations, contact Ontario Ministry of Agriculture and Food personnel. **OLD EDITIONS SHOULD BE DISCARDED** Health and Welfare Canada has established maximum residue limits (MRL's) for pesticides. However, growers should be aware that processors or retailers may demand different pesticide limits. Growers should seek advice of their intended market as to which restrictions or limitations are applicable.

FEDERAL REGISTRATION AND PROVINCIAL CLASSIFICATION

Ontario's Pesticides Act and Regulation 751, administered by the Ministry of the Environment, prohibits the sale and use of pesticide products unless they are registered under the federal Pest Control Products Act and classified under the provincial Pesticides Act by being placed in one of six schedules of the Ontario regulation.

FEDERAL REGISTRATION

There are three categories:

1. **Full Registration**
   Implies that all federal departments involved in the registration process agreed that the data package was acceptable at the time of registration.
2. **Temporary Registration**
   Indicates that there is a need for additional scientific or technical information to acquire a full registration. Temporary registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use in the following year.
3. **Temporary Registration (Restricted Class)**
   Indicates that there is an urgent need for the pesticide but that studies on the safety of the product are incomplete. Such registrations expire on the 31st of December each year and the products must be re-registered if they are to be available for use the following year.

PROVINCIAL CLASSIFICATION

Pesticide products are classified into six schedules in Regulation 751 on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration and usage. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario.

For updated information on the regulatory status of these or other pesticides contact the Agriculture & Industrial Chemicals Section, Hazardous Contaminants Coordination Branch, Ministry of the Environment, Toronto. Telephone (416) 323-5095.

E R R A T A

Publication 363
1992 - 1993

Vegetable Production Recommendations

Pages 81, 82

The list of Factsheets and publications is not correct. Not all titles are available as listed. We have had additional deletions since the time of printing.

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PESTICIDE RESISTANCE

Many of the pesticides recommended have a very specific mechanism of action; that is, they act on a single system or site in the organism. These materials **should not be used continuously and repeatedly** in a season-long program, since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Lannate, the pyrethroids (Ambush, Belmark, Pounce), etc.

In our recommendations we suggest that such compounds be used in **combination with other pesticides or that they be alternated with other pesticides** so that the likelihood of resistance development is reduced.

It should be noted that several pesticides may act similarly. Thus, parathion and Guthion, for example, act on the same site, and if resistance develops to one, it is likely to also apply to the other (this is called cross-resistance). Thus, alternating these compounds will not be useful. Rather, they should be alternated with insecticides with different modes of action: for example, Thiodan.

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

HORTICULTURAL CROP ADVISORS

County	OMAF office	Telephone	Advisor
Essex	46 Fox St. Essex, N8M 2S2	(519) 776-7361	**LESLIE HUFFMAN** Research Station Harrow, N0R 1G0 Phone: (519) 738-2251
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Oxford	Box 666 Woodstock, N4S 7Z5	(519) 539-6621	**KEITH PRIEST** Box 666 Woodstock, N4S 7Z5 Phone: (519) 537-6623
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Simcoe South	Box 370 Alliston, L0M 1A0	(705) 435-5521	
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York	1110 Stellar Dr. Newmarket, L3Y 2N1	(416) 527-2995	**CHRIS KESSEL** Unit 9, 35 Van Kirk Dr. Brampton, L7A 1A5 Phone: (416) 451-5474
Peel	Unit 9, 35 Van Kirk Dr. Brampton, L7A 1A5	(416) 451-5474	

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Durham West	Box 309 Uxbridge, L0C 1K0	(416) 852-3328	
Victoria-Haliburton	322 Kent St. W. Lindsay, K9V 2Z9	(705) 324-6125	
Northumberland	Box 820 Brighton, K0K 1H0	(613) 475-1630	**DAVE RIDGWAY** S.E.F., Box 340, Trenton, K8V 5R2 Phone: (613) 392-3527
Peterborough	55 George St. N. Peterborough, K9J 3G2	(705) 745-2403	
Prince Edward	Box 470 Picton, K0K 2T0	(613) 476-3224	**ALLAN MOYNES** Box 470 Picton, K0K 2T0 Phone: (613) 476-3224
Hastings	Box 340 Stirling, K0K 3E0	(613) 395-3393	
Lennox and Addington	41 Dundas St. W. Napanee, K7R 1Z5	(613) 354-3371	
Frontenac	Box 651, 1055 Princess St. Kingston, K7L 1H3	(613) 545-4360	
Leeds	Box 635 Brockville, K6V 5V8	(613) 342-2124	**KEVIN SCHOOLEY** Adm. Bldg. College of Ag. Tech. Kemptville, K0G 1J0 Phone: (613) 258-8359
Grenville	Box 2004 Kemptville, K0G 1J0	(613) 258-8298	
Dundas	Box 488 Winchester, K0C 2K0	(613) 744-2313	
Stormont	Box 97 Avonmore, K0C 1C0	(613) 346-2143	
Lanark	10 Sunset Blvd. Perth, K7H 2Y2	(613) 267-1063	
Renfrew	315 Raglan St. S. Renfrew, K7V 1R6	(613) 432-4841	
Carleton	26 Thorncliff Pl. Nepean, K2H 6L2	(613) 828-9167	
Prescott	Box 110 Plantagenet, K0B 1L0	(613) 673-5115	
Russell	Box 540, 666 Notre Dame St. Embrum, K0A 1W0	(613) 443-3391	
Glengarry	Box 579, St. George St. E. Alexandria, K0C 1A0	(613) 525-1046	

Potato Specialist	Sam Squire	Box 370 Alliston, L0M 1A0 Phone: (705) 435-5521
Greenhouse Specialist Vegetables	Shalin Koshla	Research Station Harrow, N0R 1G0 Phone: (519) 738-2251
Greenhouse Specialist Floriculture	Wayne Brown	HRIO, Vineland Station, L0R 2E0 Phone: (416) 562-4142
Greenhouse Specialist Bedding plants/flowers	John Hughes	Dept. of Hort. Sci. U of Guelph Guelph, N1G 2W1 Phone: (519) 824-4120, ext. 8910
Turfgrass Specialist	Pam Charbonneau	Dept. of Hort. Sci. U of Guelph Guelph, N1G 2W1 Phone: (519) 824-4120, ext. 2597
Direct Farm Sales	Bob Cobbledick	Ext. Bldg. Vineland Station, L0R 2E0 Phone (416) 562-4147
Maple Syrup Specialist	John Butler	Box 340 Elmvale, L0L 1P0 Phone: (705) 322-2231
Agroforestry Coordinator	Clarence Coons	Box 2004 Kemptville, K0G 1J0 Phone: (613) 258-8301

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

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Kent	Box 726 435 Grand Ave. W. Chatham, N7M 5L1	(519) 354-2150	Gillian Ferguson Greenhouse Veg. Research Station Harrow, N0R 1G0 Phone: (519) 738-2251
			Janice Elmhirst Tomatoes/Processing Veg. College of Ag. Tech. Ridgetown, N0P 2C0 Phone: (519) 674-5456
Lambton	Box 730 Petrolia, N0N 1R0	(519) 882-0180	Paul Hagerman European Corn Borer Cutworms/Apples 50 King St. London, N6A 2P2 Phone: (519) 434-6811
Middlesex	50 King St. London, N6A 2L3	(519) 434-6811	
Huron	Box 159 Clinton, N0M 1L0	(519) 482-3428	Richard Parry Rutabaga/Muck/Veg. Centralia College of Ag. Tech. Huron Park, N0M 1Y0 Phone: (519) 228-6691
Norfolk	Box 587 Simcoe, N3Y 4N5	(519) 426-7120	Bernt Solymar Apples/Pesticide Alternatives Box 587, Simcoe, N3Y 4N5 Phone: (519) 426-7120
Haldimand	Box 129 Cayuga, N0A 1E0	(519) 772-3381	
Brant	Unit 7 515 Park Rd. N. Brantford, N3R 7K9	(519) 759-4190	
Niagara North	Adv. Serv. Bldg. Vineland Station, L0R 2E0	(416) 562-4147	Gerald Walker Peaches/Tender Fruit/Small Fruit
Niagara South	726 Canboro Rd. Fenwick, L0S 1C0	(416) 892-4741	
Simcoe North	Box 340 Elmvale, L0L 1P0	(705) 322-2231	Alison Watson Apples/Asparagus/Strawberries Box 69 Clarksburg, N0H 1J0 Phone: (519) 599-2042
Simcoe South	Box 370 Alliston, L0M 1A0	(705) 435-5521	
Dufferin	R.R. #4 Orangeville, L9W 2Z1	(519) 941-3830	
Grey	181 Toronto St. S. Markdale, N0C 1H0	(519) 986-2040	
Durham West	Box 309 Uxbridge, L0C 1K0	(416) 852-3328	Andrea Clarke Apples/Fresh Veg. Pathology 60 Vanedward Drive Port Perry, L9L 1G3 Phone: (416) 623-3348
Durham East	60 Vanedward Drive Port Perry, L9L 1G3	(416) 623-3348	
Victoria- Haliburton	322 Kent St. W. Lindsay, K9V 2Z9	(705) 324-6125	
Peel	35 Van Kirk Dr., Unit 9 Brampton, L7A 1A5	(416) 451-5474	
Northumberland	Box 820 Brighton, K0K 4X1	(613) 475-1630	Apples/Processing Veg. S.E.F., Box 340 Trenton, K8V 5R5 Phone: (613) 392-3527
Peterborough	55 George St. N. Peterborough, K9J 3G2	(705) 745-2403	
Prince Edward	Box 470, Picton, K0K 2T0	(613) 476-3224	
York (Bradford Marsh)			Jim Chaput Onions/Carrots Muck Research Station R.R. #1, Kettleby, L0G 1J0 Phone: (416) 775-4261

PESTICIDES-CONTROL FIELD OFFICES

ONTARIO MINISTRY OF THE ENVIRONMENT

County	Field office	Telephone
Essex, Kent, Lambton	H.E. Collins P.O. Box 726, 435 Grand Ave. W. Chatham, Ontario N7M 5L1	(519) 354-2150
Elgin, Middlesex, Oxford	D.C. Morrow/W. Lampman 985 Adelaide St. S. London, Ontario N6E 1V3	(519) 661-2200
Haldimand, Norfolk, Niagara, Hamilton, Wentworth, Dufferin, Wellington, Waterloo, Brant	P. McCubbin/L. Dennie Ontario Government Building 119 King St. W. Hamilton, Ontario L8N 3Z9	(416) 521-7640
Bruce, Grey, Huron, Perth	B.T. Lobb Ont. Min. of Agr. & Food Bldg. 20 King St., Box 688 Clinton, Ontario N0M 1L0	(519) 482-3428
Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	A.G. Carpentier/H. Ploeg/C. Zubovits 7 Overlea Blvd., 4th floor Toronto, Ontario M4H 1A8	(416) 424-3000
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George St. N. Peterborough, Ontario K9J 3G6	(705) 743-2972
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon/M. Ferguson 133 Dalton Ave., Box 820 Kingston, Ontario K7L 4X6	(613) 549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204 Ottawa, Ontario K1V 7P1	(613) 521-3450
Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Timiskaming, Algoma	T. Spires/J. Negusanti/K. McDonald 199 Larch Street Sudbury, Ontario P3E 5P9	(705) 675-4501
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Buildings 435 James St. S. Thunder Bay, "F", Ontario P7C 5G6	(807) 475-1215
Head Office Hazardous Contaminants Branch	Pesticides Section Hazardous Contaminants Branch 135 St. Clair Ave. W., Suite 100 Toronto, Ontario M4V 1P5	(416) 323-5095
Pesticide Licencing & Examination Section	Environmental Approvals Branch 250 Davisville Ave., 3rd Floor Toronto, Ontario M4S 1H2	(416) 440-3713

PUBLICATIONS — The following publications are available from any of the Pesticide Control Field offices or from Pesticides Section, Suite 100, Ministry of the Environment, 135 St. Clair Ave. W., Toronto, Ontario M4V 1P5:

— Personal Protective Equipment for Pesticide Users
— Chemical Safety Handbook
— Pesticides Act and Regulations
— Chemical Storage Signs

PRECAUTIONS WITH ALL PESTICIDES

Read this entire section before using any pesticides.

GENERAL PRECAUTIONS

1. Always read the label before opening pesticide containers, and follow all precautions and directions. Before starting keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident.
2. Use an anti-back flow device, to prevent back siphoning, when drawing water from wells, ponds, streams and other sources of water. Mix pesticide into the tank with sprayer at least 50 m from the water source. Triple or pressure rinse the empty container and add rinse water to tank. Only mix enough solution to do the spray job. After loading and mixing, wash down gloves and boots with clean water before removing.
3. Never smoke, chew tobacco or eat while handling or applying pesticides. **Do not** carry tobacco or food items in clothes worn while spraying. Change clothing and wash before eating.
4. When handling and mixing pesticide concentrates, rinsing empty containers or repairing leaks, a full set of protective clothing should be worn including water proof cap, coveralls, impervious gloves and boots and eye protectors. If highly or extremely toxic pesticides are being used, a respirator should be worn. If very dusty formulations are being handled a dust mask should be used. If volatiles or gases are being handled, a respirator must be worn. If these gases are highly dangerous or in an enclosed space, a self contained breathing apparatus may be needed.
5. During application a tractor cab with charcoal filter gives adequate protection against exposure. Impervious gloves and boots and coveralls and cap should be worn when tending to stoppages. When using airblast and mist blowers and tractors without cabs, waterproof suits including caps and impervious gloves and boots should be worn. When applying fumigants in the field, a respirator should be available for problems with equipment or if the fumigant is not adequately sealed in the soil and escapes.
6. When the spray operation is complete, bath or shower after spraying to remove pesticide deposits on the skin. Avoid handling anything in the home before bathing.
7. Well, pond and surface water may be contaminated by pesticides. Every effort should be made to avoid this from happening. For more details see Factsheets *Management of Pesticides on the Farm,* Agdex 607; *Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure,* Agdex 607. It is an offence to contaminate surface waters with pesticides. To prevent this from occurring:
   - — keep pesticide concentrates above flood plain in a locked storage.
   - — after emptying, triple or pressure rinse, crush and dispose of containers.
   - — mix concentrate and water at least 50 m away from any water supply.
   - — use appropriate buffer zones and berms to avoid surface water contamination or wells, ponds and streams.
   - — if possible, do not use drinking water sources to fill spray equipment.
   - — do not spray within 10 m of shallow wells or 5-10 m of other water supplies under ideal conditions and farther away if there is any air movement. Stop spraying when wind velocity reaches 10 km/hr.
   - — there are government programs to protect your water supply and assist in building pesticide storage facilities.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash gloves, boots, respirator before and after removal. Presoak clothes and double launder immediately. If the spill was serious, place the clothes in a plastic bag and dispose in a safe manner.
2. If clothing becomes wet with a pesticide, during spraying, remove it immediately, wash and put on freshly laundered clothes.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common-name chemicals with you to the hospital. (See Emergency Procedures for Pesticide Poisoning on the back cover.)
4. Clean up any pesticide spills immediately. In case of minor spills, use dry soil or other absorbent material to remove excess liquid and sweep up powders and granulars. Contaminated soil and sweepings should be spread over a larger area or bare soil to facilitate rapid degradation. Make sure you are adequately protected when cleaning up the spill.

IN THE CASE OF A MAJOR PESTICIDE "SPILL" THE MINISTRY OF THE ENVIRONMENT, SPILLS ACTION CENTRE, 5TH FLOOR, 7 OVERLEA BLVD., TORONTO, ONTARIO M4H 1A8, TELEPHONE: (416) 965-9619 OR 1-800-268-6060 ***MUST BE NOTIFIED***

5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies,* Agdex 607.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING & FIRST AID INFORMATION
(see back cover)

RELATIVE TOXICITY TO APPLICATOR

DEFINITIONS

Lethal dose 50% (LD_{50}) The dose which when administered will kill 50% of the test animals within a stated period of time. (i.e. 1 to 6 days).

Acute Toxicity Immediate adverse effects from a single or short period exposure to a substance, either by the oral, dermal or inhalation route.

Chronic Toxicity Adverse effects resulting from repeated exposure to a substance over an extended period.

High Acute Toxicity These pesticides are extremely dangerous if handled carelessly. The acute oral LD_{50} are less than 50 mg/kg of body weight and the acute dermal LD_{50} less than 200 mg/kg body weight. These pesticides can be fatal by swallowing less than .1 to 3 mL (one drop to half a teaspoonful). These pesticides carry the skull and crossbones in a stop sign. In using these products a respirator and eye protection is required along with all other protective clothing.

azinphos-methyl (Guthion)
carbofuran (Furadan)
disulfoton (disyston)
endosulfan (Thiodan)
fonofos (Dyfonate)
methamidophos (Monitor)
methomyl (Lannate)
methyl bromide (MC-2, MB-C_2)
oxamyl (Vydate)
parathion

Moderate Acute Toxicity These pesticides are dangerous if handled carelessly. The acute oral LD_{50} is 50 to 500 mg/kg of body weight and the acute dermal LD_{50} is 200 to 2000 mg/kg body weight. These pesticides can be fatal by swallowing 3 to 30 mL (half a teaspoonful to 2 tablespoonful). These pesticides carry the skull and crossbones on a stop sign. In using these products a respirator and eye protector are recommended when handling the concentrate along with all other protective clothing.

chlorpyrifos (Lorsban)
1,3-D (Telone II, Telone C-17, Vorlex Plus, Vorlex Plus CP)
diazinon (Basudin)
dimethoate (Cygon)
Lindane
oxydemeton-methyl (Metasystox R)
phosmet (Imidan)
pirimicarb (Pirimor)

Low Acute Toxicity These pesticides are not fatal unless deliberately ingested in amounts of over 30 mL (1 oz.). The acute oral LD_{50} is greater than 500 mg/kg body weight and the acute dermal LD_{50} greater than 2000 mg/kg body weight. Pesticides listed in this publication and not appearing in the lists in this section have low acute toxicities and should be handled with precaution. Protective clothing are required. Respirators are advised when used in confined spaces. Eye protection is advisable.

Chronic Toxicity It is not possible to assess chronic toxicity of a pesticide in the same way as an LD_{50} is used to determine acute toxicity. Instead, a number of tests are performed on animals which help predict whether a pesticide will cause a number of possible long-term effects. Animals are examined for a wide variety of toxic effects such as the production of tumours or abnormalities. Protective clothing and equipment is advisable to reduce exposure and the risk of chronic effects.

1,3-D (Telone II, Telone C-17, Vorlex Plus, Vorlex Plus CP)

REENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling the treated plants or from inhalation of pesticide fumes.

The following pesticides are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended:

24 HOURS	48 HOURS	7 DAYS
mevinphos (Phosdrin)	azinphos-methyl (Guthion)	parathion
methidathion (Supracide)	carbofuran (Furadan)	
methomyl (Lannate)	methamidophos (Monitor)	
oxamyl (Vydate)	oxydemeton-methyl (Metasystox-R)	

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating the serum and red blood cholinesterase levels. If the activity of the cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms.

For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value, the tests should begin **before** using these pesticides and not after applications have started, since the normal level per individual can vary considerably, making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are those listed as:

azinphos-methyl (Guthion, APM)
carbaryl (Sevin)
carbofuran (Furadan)
chlorpyrifos (Lorsban)
diazinon (Basudin)
dimethoate (Cygon)
disulfoton (Di-Syston)
fonofos (Dyfonate)
methidathion (Supracide)
methomyl (Lannate)
oxamyl (Vydate)
oxydemeton-methyl (Metasytox-R)
parathion
phosmet (Imidan)
phorate (Thimet)
pirimicarb (Pirimor)

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. **Why Use Personal Protection?** Pesticide formulations vary in their toxicity from slightly to extremely poisonous. Once the pesticide is removed from the container, exposure occurs. The toxicity of the pesticide and the exposure to the user creates a hazard which varies from spray operation to spray operation. Both can be reduced, toxicity by dilution and exposure by protective clothing. The action taken by the applicator to reduce the hazard of a spray operation reduces the risk of poisoning. While the hazard of a situation remains, the risk can be reduced by the care and protection followed by the applicator. Wearing the required protective clothing reduces the risk.

2. **Risk of each stage in pesticide operation**
   (1) Handling and mixing concentrate — very high risk
   (2) Rinsing empty containers — high risk
   (3) Application outdoors — low to high risk
   (4) Application indoors — medium to very high risk
   (5) Cleanup, equipment rinsing — medium to high risk
   (6) Re-entry into treated area up to 48 hours — low to medium risk.

3. **Exposure of each stage in pesticide operation.** Approximately 80-85% of the exposure in most spray operations is during mixing and loading of the concentrate. Field application usually accounts for 15-20% of the exposure. Skin exposure is usually 90 to 100% of the total exposure and around 70% of this is by way of the hands and forearms and 30% involves the rest of the body. Inhalation (nose and mouth) exposure is normally 0.1% but raises to 5-10% with mist blowers and air blast sprayers.

4. **To reduce skin (dermal) exposure,** wear impervious gloves (neoprene, nitrile etc.) and waterproof boots, along with coveralls, apron or spray suits and waterproof cap. Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Polyester is more easily penetrated than cotton. Disposable coveralls are polyethylene and can be laundered several times. Spray suits should be used in highly hazardous conditions as with mist blowers and air blast machines. Eye protection should be practised with all pesticide concentrates.

5. **Respirators are recommended** when handling pesticides with labels carrying the warning stop sign with skull and crossbones that call for respiratory protection. Respirators should be used when spraying all pesticides rated as high toxicity or applying any liquified gas. Respirators come in a wide range of shapes and sizes; consult the label and your nearest safety supply company for advice.

6. **Washing and laundering protective clothing** keeps your protective clothing and equipment functional: clean it thoroughly. Never allow children or pets to come into contact with contaminated clothing or equipment. To this end, launder clothing promptly, wash and store other items used for personal protection and rinse down spray equipment and store to prevent children playing on it. Here are some general guidelines for cleaning items used for personal protection.

   (1) **Fabric clothing** — if fabric clothing is saturated with the concentrate of a highly toxic pesticide, discard the clothing. Remove the clothing carefully and immediately place in a plastic trash bag and dispose in a safe manner. Wear vinyl, or plastic gloves when handling severely contaminated clothing. Presoak and double launder clothes that may have been contaminated by a normal spray operation preferably twice a day but at least at the end of the work day, following these guidelines:
      — prerinse clothing outdoors
      — presoak in a suitable container such as a large bucket or tub; or use the prewash cycle of an automatic washer, with detergent
      — wash contaminated clothing separately from all other clothing
      — prewash solvent-based products have been found effective on EC formulations
      — wash clothes using hot water, the highest water level, and a regular hot super wash cycle
      — use heavy-duty liquid detergents for all pesticides and use adequate amounts (see laundry detergent box)
      — wash only a few contaminated garments at a time
      — use two complete wash cycles each with a double rinse
      — after washing run another wash cycle with detergent and no clothing to decontaminate the washing machine
      — line dry to avoid a potential build-up of pesticide residue in the dryer.

   (2) **Rubber, Vinyl, or Plastic Boots and Gloves** — to avoid getting pesticide on your hands, wash the outside of boots and gloves with detergent and water before removing. After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly, and dry in a well-ventilated area.

   (3) **Chemical-Resistant Clothing, Goggles and Face Mask** — wash plastic or rubber clothing and equipment with detergent and water, rinse thoroughly, and dry in a well-ventilated area.

   (4) **Respirators** — Discard cartridges, canisters and filter pads either: (1) when breathing becomes difficult, (2) when a pesticide odour is noticed, or (3) at the time interval specified by the manufacturer. Write the date of the cartridge when it is first used. Wash the face piece in detergent and water, rinse it thoroughly, and dry it in a well-ventilated area. Never use alcohol or other solvents for cleaning — they will damage rubber and plastic.

7. **Consult the safety supply house** of your choice for appropriate guidance and selection of your protective clothing.

PROTECTIVE CLOTHING WHEN USING PESTICIDES IN GREENHOUSES, MUSHROOM HOUSES, GRAIN STORAGES AND OTHER ENCLOSED AREAS

Respiratory Protection — Available Devices

Air Purifying Devices — Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapours and particulate matter which otherwise might be harmful to life or health. From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Self-contained Breathing Apparatus

In confined spaces where gas concentrations are usually high, oxygen can be deficient and conditions can be fatal. Under these conditions air purifying apparatus fail to work. The applicator needs an air supply and this is provided by a self-contained breathing apparatus, e.g., Scott Air Pack. The use of substances that produce hydrogen cyanide, methyl bromide, chloropicrin, or phosphine can all produce high gas concentrations and oxygen deficiency as can smoke generators and even foggers using highly toxic pesticides and some volatile sprays. Greenhouse and mushroom house operators need this type of apparatus if using these toxic gases, smokes, fogs or sprays.

OTHER PROTECTIVE CLOTHING

Wear other protective clothing in keeping with requirements on the label.

WORKING CONDITIONS

Low Concentrations

Canister gas masks may be used when the surrounding air contains low concentrations of toxic gases, vapours or particulate matter derived from soil-drench, granular, dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. However, because they are available as granules, the wearing of a canister gas mask provides protection. Contact your safety supply company for the proper canister selection.

High Concentrations

Use only a self-contained breathing apparatus, e.g., Scott Air Pack, in the following instances when high concentrations are produced. High concentration of toxic gases, vapours or particulate matter can be produced when applying highly toxic pesticides such as:

1. When fumigating grain — methyl bromide
2. When fumigating soil — methyl bromide, 1, 3 Dichloroprene (Telone & Vorlex)
3. When fogging — Parathion
4. When using smoke generators — Parathion, Lindane
5. When using high pressure, mist, application — Dichlorvos

Contact your safety supply company for their recommendation for each.

SPACE FUMIGANTS AND INSECTICIDE SMOKES

General

When using fumigants or insecticide smoke generators, wear appropriate protective clothing to prevent skin and inhalation exposure. After treatment lock the building where the extermination is being performed and post warning signs. Follow instructions on the product label regarding aeration of treated buildings, warehouses, grain storage bins or areas and greenhouses before permitting re-entry. **BECOME FULLY AWARE OF THE HEALTH HAZARDS AND TOXIC PROPERTIES OF THE PESTICIDE THAT YOU ARE USING.**

Fumigants

An agriculturalist using methyl bromide plus chloropicrin or aluminum phosphide to fumigate greenhouses, vaults, warehouses, and grain storage must obtain a permit issued under the Pesticides Act. To apply for a permit contact the local Pesticide officer with the Ministry of Environment.

When handling methyl bromide, do not wear any gloves because these will trap gas close to the skin. A full face respirator with organic vapour canister or positive pressure breathing apparatus must be worn. A second person with personal protective equipment should be assisting during the fumigation.

When handling aluminum phosphide, use of cotton gloves are recommended. A full face mask respirator with an acid gas canister should be worn. A second person with personal protective equipment should be assisting during the fumigation. Always consult the product label.

For further information, obtain *Methyl Bromide Structure Fumigation Procedures* and *Aluminum Phosphide Structure Fumigation Procedures* from the Ministry of the Environment Offices.

SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/OR RESPIRATORY DEVICES FOR OUTDOOR PROTECTION AGAINST CERTAIN PESTICIDES

Respiratory Devices Manufactured by:	Available From:
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 80 Centurion Drive, Markham L3Y 5Y5, Tel. (416) 479-4545 Branches: Hamilton & Belleville
H.S. Cover (York) Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, Sarnia, Stoney Creek, Sudbury and Thunder Bay
Kasco Helmets	The St. George Co., R.R. #1, St. George N0E 1N0, Tel. (519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York M3N 1X8, Tel. (416) 667-9400
3M-Canada Inc. Occupational Health & Environmental Safety Products Division	P.O. 5757, London, Ont. N6A 4T1, Tel. (519) 451-2500
Racal Airstream Scott Willson	Safety Supply Canada, 90 West Beaver Creek Road, Richmond Hill (Toronto) L4B 1E7, Tel. (416) 222-4111 or (416) 222-2111 Branches: Hamilton, Kingston, Kitchener, London, St. Catherines, Sarnia, South Porcupine, Thunder Bay and Windsor
North	Siebe-North Inc., 27 Dansk Court, Rexdale M9W 5V8, Tel. (416) 675-2810
Safety House	Safety House of Canada Ltd., 1275 Castlefield Ave., Toronto M6B 1G4, Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines and Stoney Creek

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

STORAGE

1. **General Storage**
   The Ontario Pesticides Act and Regulation 751 require all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.
2. **Special Storage**
   (1) Schedule 1, 2 and 5 pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words **"CHEMICAL STORAGE**

WARNING AUTHORIZED PERSONNEL ONLY" in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

(2) **Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers.** See also OMAF Factsheet, *Farm Storage of Pesticides,* Agdex 607.

(3) In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high-water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems affecting humans and domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS OR CONTAMINATED MATERIAL

1. All paper or cardboard pesticide containers or paper packaging material, or other paper material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke, and that the smoke is not directed toward buildings, highways, roads, or outdoor public areas. Plastic material must not be burned.
2. Unrinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the container it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful — use that 3% for the purpose for which it was purchased, i.e. to control the pest!
3. Rinse all empty metal, plastic or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic container, and to rinse the residue left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table, or disposed of at a landfill site.
4. Unwanted or contaminated pesticide product should be disposed of through TRICIL Environmental Management (1-800-263-2432), or, by contacting the appropriate registrant to develop an alternative method acceptable to the Director under the Pesticide Act. (1-416-323-5095).

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, and reduce the amount of material in the target area so that it is ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

1. correct calibration and maintenance of spray equipment
2. correct operation of the equipment
3. being aware of the toxicity of the pesticide being used
4. being aware of the weather conditions

For more information consult OMAF Factsheet, *Pesticide Drift,* Agdex 607, or Canadex 607, *Pesticides: effects of drift and droplet size.*

PESTICIDE APPLICATION BY AIRPLANE OR HELICOPTER

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offence under the Federal Pest Control Products Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl).

Applications should not be made if the wind is blowing. Even on the stillest day, some drift occurs; to keep it to a minimum apply pesticides in the evening or early morning.

Be sure that the contract specifies the product to be used and its rate of application.

RESIDUE TOLERANCES AND DAYS TO HARVEST

Tolerances for residues of agricultural chemicals on vegetables when offered for sale have been set by Health and Welfare Canada. To avoid exceeding the residue tolerance for insecticides, herbicides and fungicides:

— **DO NOT APPLY THEM LATER THAN RECOMMENDED.**
— **DO NOT APPLY MORE THAN THE RECOMMENDED AMOUNT.**
— **DO NOT APPLY THEM MORE OFTEN THAN RECOMMENDED ON THE LABEL.**

When controlling insects, for example, **do not apply an insecticide later than the number of days from harvest given in brackets after the recommendation.** Malathion 25 WP 4.5 kg (7 days) indicates that the malathion spray should not be used later than 7 days before beginning of harvest, and that no more than 4.5 kg of a wettable-powder formulation containing 25% malathion should be used for one hectare of crop in an application.

CROP INSURANCE

The Canada-Ontario Insurance Program is publicly funded by the Government of Canada and the Province of Ontario. The Federal and Provincial governments each contribute 25% of the premium cost and 50% of the administrative costs.

Both of these contributions enable the Ontario grower to purchase insurance coverage at a premium approximately equal to 44% of the total cost.

The grower's premium payment is considered an operating expense for income tax purposes. Crop insurance offers protection against loss from a broad range of production hazards, including excessive rain, excessive drought, winter damage, frost, hail, wind, certain pests and diseases, etc.

For further information contact your local insurance agent or:

The Crop Insurance Commission of Ontario
Ministry of Agriculture and Food
Legislative Buildings, Queen's Park
TORONTO, Ontario, M7A 1B7
416-326-3276

For those crops listed and followed by "processing", be advised that insurance contracts are available through processing companies only. Insurance contracts for all other crops listed are available from Crop Insurance Agents only.

VEGETABLE CROPS
Asparagus
Beans (green & wax, processing only)
Beets
Broccoli
Cabbage
Carrots
Cauliflower
Celery
Cucumbers
Lettuce
Lima Beans (processing)
Parsnips
Peas (processing)
Peppers
Potatoes
Pumpkins
Rutabagas
Seed Onions
Set Onions
Spanish Onions
Squash
Sweet Corn (fresh)
Sweet Corn (processing)
Tomatoes (fresh)
Tomatoes (processing)

FRUIT CROPS
Apples
Grapes
Peaches
Pears
Plums
Sour Cherries
Strawberries
Sweet Cherries

GENERAL CROPS
Canola
Coloured Beans
Corn (grain & silage)
Hay
Honey
Forage
New Forage Seeding
Peanuts
Popcorn
Red Spring Wheat
Seed Corn
Soybeans
Spring Grain
Sunflowers
White Beans
Winter Wheat

TOBACCO
Flue Cured
Black

Insurance contracts for processing crops are available through processing companies only.
Insurance contracts for all other crops are available from crop insurance agents only.

SPRAY-TANK MIXTURES IN ALKALINE WATER

Because many pesticides are susceptible to alkaline water[1], it is recommended that pesticides diluted with alkaline water be used immediately.

However, "spraying immediately" is not always possible owing to unexpected reasons; rain, wind, sickness, etc. Any lengthy delay in applying spray mixtures may result in pesticide loss due to degradation[2] and possibly a corresponding decrease in control.

To avoid this possibility, it is recommended that alkaline water be neutralized before adding any pesticides. Dissolve ammonium dihydrogen phosphate[3] (same material is also called mono-ammonium phosphate or ammonium phosphate, monobasic) at the rate of 50 g per 100 litres of water, and then add pesticides. Alternatively, LI 700 used at a rate of 125 mL to 250 mL in 100 L of water may be mixed into the tank water before adding any pesticides.

The phosphate is not always necessary, but this practice is a sort of insurance. The cost of the phosphate is substantially less than that of the pesticides. Also, the added phosphate will be available as a foliar nutrient.

Occasionally, water-soluble fertilizers are used with pesticides as a tank mixture. This practice is not encouraged because most of the water-soluble fertilizers are strongly alkaline. If these fertilizers are used, the amount of phosphate recommended is not sufficient to neutralize the water.

[1] *Most of the water being used in the Holland Marsh and many water sources in the Niagara Peninsula are fairly alkaline (pH 7.5 - 9.0). Possibly, there are other areas in Ontario where alkaline waters are being used.*

[2] *The rate of degradation is dependent on the pesticide, the concentration of pesticide in the tank (dilution factor), and the pH and temperature of the water.*

[3] *The phosphate is available from limited suppliers. The cost of ammonium dihydrogen phosphate is approximately $1.75 per kg (as of October, 1991). For 100 L of water, the cost (50 g of phosphate) is about 9 cents.*

COMPATIBILITY OF INSECTICIDES AND FUNGICIDES

The chart below is only a guide to mixing of spray materials.

Consult the manufacturer's label regarding compatibility of products with other pesticides. Compatibilities of some materials depend upon solvents and emulsifiers used by the manufacturer. As all manufacturers do not use the same solvents and emulsifiers, be sure to check the label or product being used for compatibility.

Chart applies only to the use of two-material spray combinations. When three or more materials are tank-mixed together, further incompatibility may develop.

COMPATIBILITY-CHART KEY

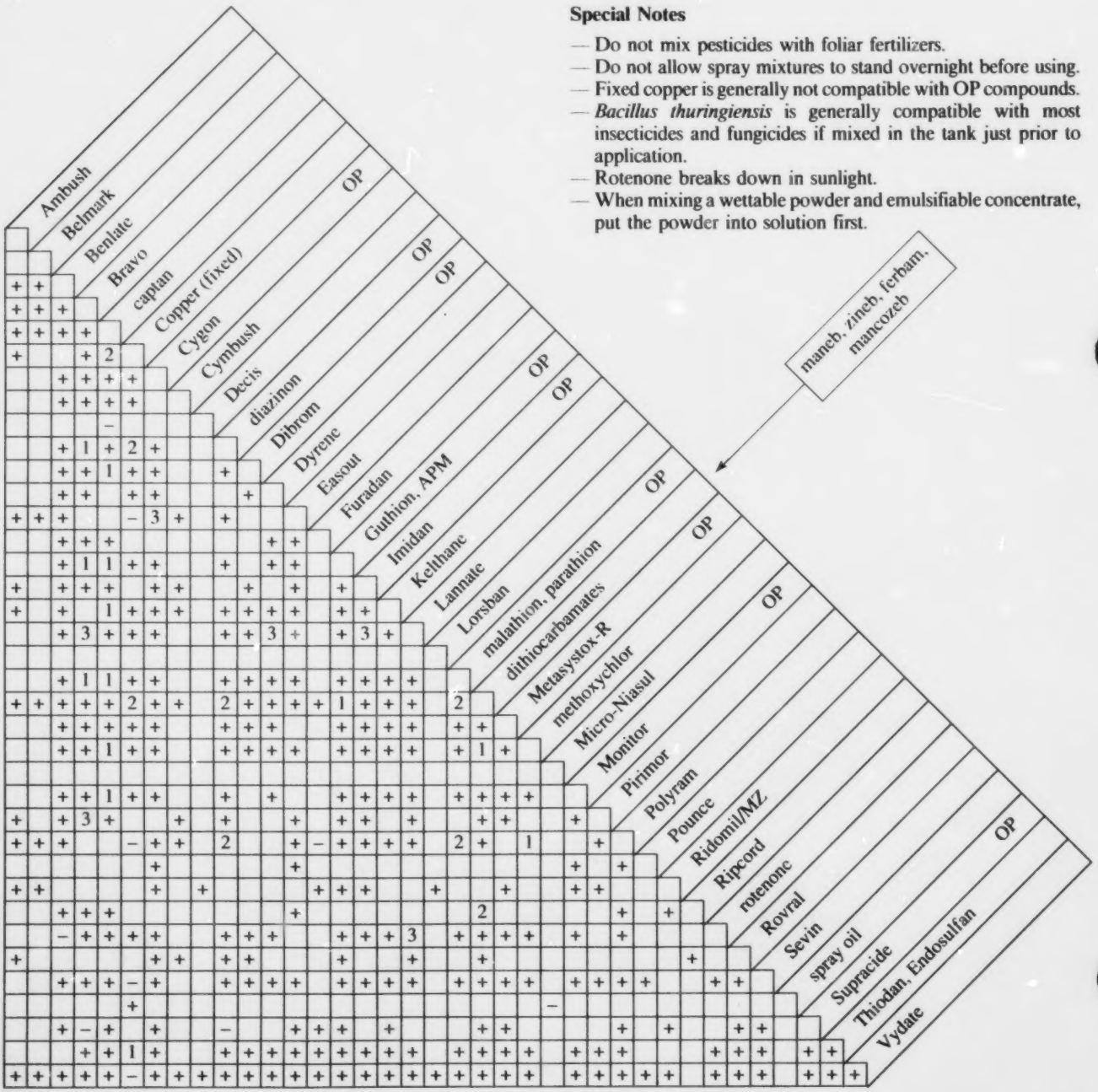
When a blank appears on the chart, the materials usually are not used together or the compatibility is not known.

\+ May be used together
— Do not use together
OP Organophosphorus compound

1 Use WP formulations
2 Apply immediately with tank agitation
3 Use with caution (possible plant injury)

Special Notes

— Do not mix pesticides with foliar fertilizers.
— Do not allow spray mixtures to stand overnight before using.
— Fixed copper is generally not compatible with OP compounds.
— *Bacillus thuringiensis* is generally compatible with most insecticides and fungicides if mixed in the tank just prior to application.
— Rotenone breaks down in sunlight.
— When mixing a wettable powder and emulsifiable concentrate, put the powder into solution first.



CLIMATE OF ONTARIO

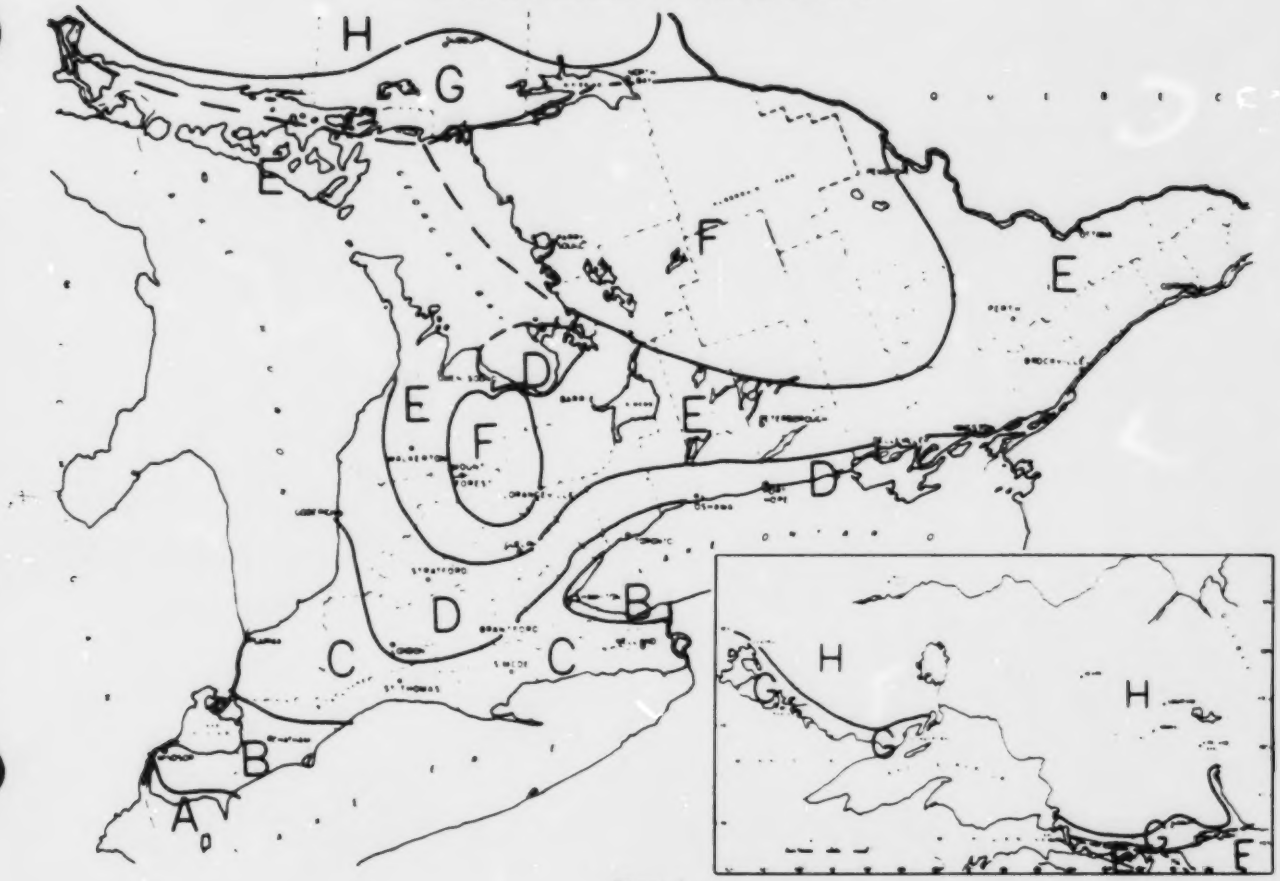


Figure 1

Most vegetable production is concentrated in southern Ontario. There are differences in climate even in this small area, particularly in the length of the growing season and in average temperatures.

Figure 1 is a Zonation Map of southern Ontario. Zone A has the longest growing season and is the small region in the Leamington-Harrow-Amherstburg area bordering on Lake Erie. The other zones are progressively shorter in growing season. The zone lines are approximate and do not represent sharp changes in climate. The gradation of temperature and growing season from one zone to another is gradual.

TABLE 1. AVERAGE FROST-FREE PERIOD IN CLIMATIC ZONES OF ONTARIO

Zone	Frost-free periods (average in days)	Average date of last spring frost	Average date of first fall frost
A	180	April 25	October 25
B	165-180	May 5	October 15
C	145-165	May 10	October 10
D	130-145	May 18	October 2
E	120-135	May 22	September 28
F	105-120	May 31	September 20
G	100-120	May 25	September 20
H	100 or less	After May 25	Before Sept. 15

Table 1 gives approximate growing periods for tender crops and average dates of first and last frost (0°C) in each zone. These average frost dates are approximate guides to the beginning and end of the frost-free period in 5 out of 10 years. For example, in past records from Zone C the last spring frost still occurred later than May 11, or the first fall frost occurred before October 7, in 5 out of 10 years. This 5-out-of-10 risk level may be excessive for planning many farm operations, so frost dates with lower risk levels may be determined as follows. Three years in 10 the first frost will occur about one week later in the spring or one week earlier in the fall than the date given in Table 1. For the 1-year-in-10 risk, the dates in Table 1 should be adjusted about 2 weeks later in spring and 2 weeks earlier in fall. For example, 1 year in 10 the last spring frost in Zone C has occurred later than May 25 or the first fall frost has occurred earlier than September 24.

Table 1 and the above paragraph refer to the occurrences of 0°C at a standard height of 1.5 metres at which time tender crops will often be damaged. Frost-hardier crops are not usually damaged until temperatures at this level drop below —2°C. The date of occurrence of —2°C is usually about 2 weeks earlier in the spring or later in the fall than the date of 0°C.

It is obvious that there are many local variations due to topography, altitude, natural air drainage and nearness to water that influence growing conditions. Cold air tends to flow, like water, into low-lying areas. Plants may be frost damaged at the bottom of a slope and not have been injured on the slope or at the top of the hill.

Particularly during spring, a south-facing slope or an area surrounded by a windbreak will be warmer than an unprotected area. These local variations must be considered in deciding the location of a planting or the time of planting.

Table 2 gives approximate first seeding or planting dates for common vegetable crops. Dates are given for Zones A, C and E. Planting dates for the other zones fall between these dates.

These dates are a guide for seeding but seasons will have to be taken into consideration. If long-term weather predictions are available, they are helpful in deciding whether to seed earlier or later than the dates given. For many crops the soil temperature is very important in determining the rate of early growth. For this reason, even if air temperatures are high, if the soil has not yet warmed up, planting should be delayed somewhat.

TABLE 2. FIRST FIELD SEEDING OR PLANTING DATES FOR COMMERCIAL PRODUCTION

Crops	Zone A	Zone C	Zone E
FROST HARDY Asparagus, broccoli, Brussels sprouts, cabbage, lettuce, onions (set, seed and Spanish) radish, rhubarb, pea, spinach, parsnip, early potato	April 1-15	April 15-25	April 25-May 10
SEMI-FROST HARDY Beet, carrot, cauliflower, celery, late potato, early sweet corn	April 15-25	April 25-May 10	May 5-15
SEMI-FROST TENDER Snap bean, sweet corn, tomato	May 1-15	May 15-25	May 25-June 5
FROST TENDER Lima bean, cucumber, eggplant, muskmelon, pepper, pumpkin, squash, watermelon	May 20-30	May 25-June 5	June 5-15

PLANT POPULATION AND PRECISION SEEDING

The use of herbicides, fertilizers, and, to some extent, irrigation, has drastically changed the way vegetable crops can and should be grown. Most crops can be grown much closer than the old conventional spacings, which were approximately the width of a horse-drawn cultivator. Much closer spacing allows more crop on the same unit of land. Each crop should be spaced according to its optimum needs. Seeding carrots 2 to 4 cm apart in all directions eliminates most stress factors, resulting in uniform carrots relatively free from disease and misshapen roots. More than 8 to 12 rows of carrots per bed, at 4 x 4-cm spacing, will interfere with light penetration of the foliage cover and adversely affect yield. Lettuce seeded in beds and spaced 30 cm between plants produces more heads per unit of land, as well as a much higher percentage of marketable heads. Onions sown in double rows 5 to 8 cm apart in and between the double rows, 4 to 6 double rows per bed, not only produce larger onions but much higher yields. The same can be said for many other crops. As plants reach the optimum spacing for their particular needs, growth improves and yields increase.

To obtain the optimum plant density, a system of precision seeding is needed. This system starts with the preparation of a fine, smooth seedbed, followed by uniform seeding at the same depth, at exact in-row and between row spacings. See crop sections for spacing requirements.

With precision seeding, the harvested product will be more uniform in size and shape. Less effort will be required in grading and packing, and fewer culls will be obtained.

However, to achieve complete success with precision seeding, all factors — seed sizing, seed coating, high germination, uniform bed characteristics, and uniform seeding depth — must be included. By omitting just one factor, the results may be no better than with more conventional seeding methods.

The distance between rows will be determined by the method used to harvest the crop. Solid-bed planting can be done with some crops.

A precision seeder delivers the seed exactly where the final plant for harvest is to be grown. If this is accomplished, and the seed germinates normally, no thinning or transplanting will be required. The "ifs" are the quality of the seed and the uniformity of the seedbed.

Another important factor to consider is the kind of seed coat. Rough or angular seed like carrot and lettuce must be coated to a smooth, uniform shape with a water-absorbing material. Onions need to be coated to be successfully precision seeded. Seeds that are naturally smooth and round, such as cabbage, cauliflower, radish and rutabaga, need only to be separated to exactly the same sizes to provide uniform growth in the field. Results with precision-seeding research in Ontario to date indicate that higher yields of better quality vegetables are possible, regardless of when the crops may be grown.

Pre-germinated seed of most species will ensure more rapid emergence and may gain time or emergence over the slower non-germinated seed. This can assist the seed to emerge before soil crusts form or weed seeds emerge.

SEEDS

APPROXIMATE PLANTING DEPTH AND NUMBER PER GRAM

Crop	Seeds per gram	Seed Planting Depth in mm	Crop	Seeds per gram	Seed Planting Depth in mm
Asparagus	50	25	Kale	270	5
Bean, snap	2-3	40	Kohlrabi	280	5
Bean, lima	1-3	40	Leek	350	15
Beet, Swiss Chard	50	15	Lettuce	700	5
Broccoli	320	5	Melon	40	25
Brussels sprouts	280	5	Mustard	550	5
Cabbage	300	5	Onion	280	15
Chinese cabbage	250	5	Parsley	550	5
Carrot	900	5	Parsnip	200	15
Cauliflower	350	5	Pea	3-6	25
Celery, Celeriac	1,800	3	Pepper	150	5
Chicory	600	5	Pumpkin	4	25
Collard	280	5	Radish	125	15
Corn	4-8	40	Rutabaga	280	5
Cucumber	40	20	Spinach	90	20
Eggplant	200	15	Squash	10	25
Endive	500	5	Tomato	350	5
			Watermelon	10	25

NUMBER OF PLANTS PER HECTARE AT VARIOUS PLANTING DISTANCES

Row Spacing in cm	Distance in the row in cm						
	10	15	30	45	60	75	90
30	333,330	222,220	111,110	74,070	55,560	44,440	37,040
45	222,220	148,150	74,070	49,380	37,040	26,630	24,690
60	166,670	111,110	55,560	37,040	27,780	22,220	18,520
75	133,330	88,890	44,440	29,630	22,220	17,780	14,810
90	111,110	74,070	37,040	24,690	18,520	16,460	12,350
110	90,910	60,610	30,300	20,200	15,150	12,120	10,100
120	83,330	55,560	27,780	18,520	13,890	11,110	9,260

WEED CONTROL

For chemical weed-control recommendations, refer to OMAF Publication 75, 1992 Guide to Weed Control. It contains details on the various herbicides, safety precautions, care and calibration of sprayers, etc.

Herbicides should not be used in greenhouses and other plant-growing structures unless specifically recommended.

Chemical weed control should never be a substitute for good cultural practices. Reduce the spread or increase of weed seeds by cutting or disking weeds before they go to seed. Concentrate on the eradication of persistent perennial weeds by cultural practices. Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Careful shallow cultivation is best. The modern grower should use chemical weed killers wherever practical as a supplement to good cultural practices.

It is very important to apply the correct dosage when using these chemicals. Herbicides can cause severe injury to the crop if more than the recommended rate is used. **Do not experiment with chemicals or mixtures which are not recommended.** If more than a permitted amount of herbicide residue is found in the crop, the entire crop can be seized without compensation to the grower.

CAUTION!

Spray drift can damage or destroy susceptible crops and shrubs for a great distance from the sprayer. Do not use 2,4-D-type herbicides near susceptible crops such as grapes, beans, tomatoes, or tobacco. Take into consideration both the direction and speed of the wind when applying this type of herbicide. Use low pressure whenever possible (200 to 250 kPa is usually enough). **Do not use the same sprayer to apply 2,4-D and similar herbicides as you use for spraying insecticides and fungicides.** Drain and wash out the sprayer immediately after use. **Do not mix different herbicides, or herbicides with other pesticides, foliar fertilizers, surfactants, or detergents unless recommended by competent authorities.**

SOIL MANAGEMENT AND FERTILIZER USE

SOIL CLASSIFICATION AND TYPE

A well-drained, sandy soil is of value for early vegetable crops. Sandy loam and silt loam soils are valuable for the production of most vegetable crops. Muck land is ideal for some salad and root crops. Clay loam and clay soils are used for certain processing crops. Proper fertilization, drainage, irrigation, and cultivation practices are essential on all soils and will extend the range of soils which may be successfully used for vegetable production.

Detailed soil maps of some counties are available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5. These maps give a very good indication of the soil type in your area, but on-the-site examination will also be necessary.

Soils which are well drained and provide a good depth of permeable rooting volume are necessary. Impervious layers or a high water table can reduce the penetration of roots by excluding oxygen. Excessive moisture can be removed by tile drainage.

SUBSIDENCE OF PEAT AND MUCK SOILS

Cultivated peat and muck soils decompose or subside (oxidize) and thus subside gradually at rates of 1 to 3 cm/year. Maintaining a high water table and a low pH reduce the rate of subsidence to less than .05 cm per year. See **OMAF Factsheet, Management of Organic Soils, Agdex 512/31,** for more detailed information on water control and recommended heights of water table for vegetable crops. However, a very wet (or very acidic) soil does not give maximum yields, and is likely to be flooded when rainfall is intense. Wet spots may also be difficult to work and result in uneven crop growth. Recent research has shown that copper (Cu) applied as fertilizer has the residual effect of slowing down degradation, and thus subsidence, by about 50%. It is recommended that 14 kg of Cu/ha be applied annually to peats and mucks in the first 3 years of cultivation and up to 5 kg of Cu/ha added every second or third year thereafter, particularly when onions, carrots or lettuce are grown on the soils.

ORGANIC MATTER AND CROP ROTATION

Soil organic matter breaks down very rapidly with the intensive cultivation used on vegetable land, especially where irrigation is practiced. While rotations including sod crops are most effective in maintaining organic matter, it may be necessary to rely on green-manure and cover crops where rotations are not feasible. Organic soils, such as peats and mucks, do not require these special practices to maintain organic matter.

Grasses or legumes should appear in the rotation on mineral soils at least once every three years, or better, twice every four years. These crops are important in the rotation, since they maintain porosity and good structure in fine-textured soils. They improve the waterholding capacity of sand and sandy loams. In addition to maintaining good soil structure, the organic matter helps to control several common soil-borne vegetable diseases.

GREEN-MANURE AND COVER CROPS

The benefit from these soil-improving crops will be greatest on a soil which is adequately fertilized. As a general rule, apply 30 to 40 kg N/ha with as much phosphate and potash as the crop requires, based on soil tests, to the soil at or before seeding. The recovery of nitrogen applied will amount to about 30% for the first vegetable crop.

The following are suggested as fall-seeded cover crops. The seeding rate is minimum.

1. Winter rye at 180 kg/ha.
2. Domestic or Italian rye grass at 22 kg/ha.
3. Spring wheat or oats at 130 kg/ha where potatoes or a small-seeded vegetable crop is planned. These crops will hold the soil, but will be killed by frost and will not cause any difficulty in seeding the next spring. Winter rye, with heavy straw growth, makes seeding difficult.

The following green-manure crops are suggested for spring seeding.

1. Soybeans at 130 kg/ha inoculated with a suitable culture and treated with a combination fungicide-insecticide seed protectant.
2. Sudan grass at 35 kg/ha where irrigation is available or soil moisture is abundant.
3. A mixture of peas at 65 kg/ha plus oats at 100 kg/ha sown as early as possible in the spring before a late-planted crop.
4. Sweet clover at 12 to 22 kg/ha or a mixture of sweet clover at 12 kg/ha plus red clover at 6 kg/ha where a soil is taken out of cultivation for one year to improve soil structure.

MANURE

Manure is a good source of organic matter and plant nutrients. Whenever available, it should be used.

For maximum conservation of plant nutrients, manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Manure is used more effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates giving more nitrogen than the crop requires.

Avoid application of liquid manure to crop foliage, as it can damage the crop.

The most effective use of manure is nitrogen. It should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However, phosphate applied after a crop is seeded may not be available to that crop. Therefore, phosphate fertilizer requirements should not be adjusted for manure applied after seeding.

If manured soil is plowed in late summer or early fall, a cover crop should be seeded. Manure containing much undecomposed straw or shavings should not be applied in the spring when potatoes are to be grown, as it may promote scab development.

The fertilizer requirements given for each crop in this publication do not contain any adjustment for applications of manure. If manure is applied, the amount of fertilizer to be deducted from the crop requirements is indicated in the accompanying table for each type of manure.

These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer.

REDUCTIONS IN FERTILIZER APPLICATION WHERE MANURE IS APPLIED IN THE SAME CROP YEAR*

Class of Livestock	Nitrogen (kg/ha) F. & W.**	Spr.**	Spr. C.**	Phosphate P_2O_5 (kg/ha)	Potash K_2O (kg/ha)
Liquid Manure at 10 cubic metres/hectare (One cubic metre + 220 imp. gal; one cubic metre/ha = 90 gal/ac)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare (66 bu. or 2.40 cubic metres of solid manure = 1 metric tonne approximately. Ten t/ha = 4.5 ton/ac.)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

* *These adjustments are based on slightly below average-quality manure.*

****F. & W.** *denotes fall and winter-applied manure;* **Spr.** *denotes spring applied and not covered immediately, including surface application after seeding;* **Spr. C.** *denotes spring-applied manure injected or otherwise covered within one day of application.*

Where the manure is applied in the fall, more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall-applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applications. Do not spread manure in winter or early spring on fields that are subject to runoff.

LONG-TERM VALUE OF MANURE

The long-term availability of phosphorus, potassium and magnesium from manure applications in previous years is best measured by a soil test. Some of the nitrogen in cattle and swine manure also continues to become available in the years following application but in successively smaller quantities. Generally, 50 percent of the total manure nitrogen applied in the spring is available (as nitrogen in chemical fertilizer) in the year of application. In the second year approximately 20% of the remaining nitrogen becomes available, 10% in the third year and 5% in the fourth year. Thus if 20 tonnes of cattle manure per hectare were applied, the amount of nitrogen available in the first year would be 48 kg N/ha. This is approximately one-half of the total nitrogen content. The amounts of available nitrogen in years 2, 3 and 4 would be 10, 4, and 2 kg N/ha, respectively. If manure has been applied annually for a number of years, the cumulative amount of nitrogen is appreciable. For example, if 20 tonnes of cattle manure per hectare were applied each year for four years, the total available nitrogen from the manure in the fourth year would be 48 + 10 + 4 + 2 = 64 kg N/ha.

Although time and method of manure application affects the amount of available nitrogen in the first year, the amounts available in subsequent years are not affected appreciably. No adjustment should be made for the long-term effect of poultry manure because most of the available nitrogen it contains is released in the year of application.

MANURE ANALYSIS

The nutrient content of manure varies not only with the type of livestock but with their age, the ration fed, the type of bedding, and amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis may be obtained from several labs in Ontario.

ADJUSTMENT OF NITROGEN REQUIREMENT FOR THE VALUE OF CATTLE OR SWINE MANURE APPLIED IN PREVIOUS YEARS

Rate of Manure Application Solid (t/ha*)	Liquid (cubic m/ha*)	Years of Manure Application	Consecutive Reduction in Crop Nitrogen Requirement kg N/ha
20	50	5	20
20	50	10	30
40	100	3	20
40	100	5	30
40	100	10	30

* *66 bu manure = 1 metric tonne approximately. 10 tonne/ha = 4.5 tons/ac. One m^3 = 220 Imperial gallons. One m^3/ha = 90 gal/ac.*

SOIL TESTING

Before planting any crop get a soil test. Soil tests give you information on the nutrient elements available in soil but cannot tell the suitability of a soil for a specific crop.

The soil test can:

1. indicate the kind and amount of lime required;
2. measure the soil nutrients available for crop production;
3. provide the basis for suggested rates for fertilizer applications.

Soil testing is currently by far the most accurate tool available in Ontario to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to crops.

OTHER METHODS OF ASSESSING NUTRIENT NEEDS

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.

2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen as, with some crops, the suggested rate approximates what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years, and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser-textured soils.

To determine your fertilizer requirements for a specific crop on a specific field, the soil testing program is the main guide, with some help from plant analysis and nutrient deficiency symptoms.

ANALYSES AVAILABLE THROUGH VARIOUS SOIL TESTING SERVICES. COSTS MAY VARY FROM THOSE LISTED BELOW.

MATERIALS	WHAT IS ANALYZED	COST PER SAMPLE**
1. Field Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement; Calcium (on tobacco soils only)	$11.00
2. Home Garden and Lawn Soils	Plant-available Phosphorus Potassium, Magnesium; pH; Lime requirement	$12.00
3. Commercial Turf Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	$11.00
4. Greenhouse Media, Water* and Nutrient Solutions*	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulfates; Chlorides; Total Salts	Basic $11.50
5. All Soils (optional, on request only)	Plant-available Manganese and Zinc	$4.00
6. All Soils (optional, on request only)	Organic Matter	$6.00

**Laboratory requires 500 mL sample.* ***These are costs for basic tests; please add PST + GST.*

WHAT DOES THE OMAF SOIL TESTING PROGRAM PROVIDE FOR THE FARMER?

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer, along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum yields under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done: (a) for maintenance (to maintain high soil-nutrient levels); and, (b) to allow for some error in sampling the field.

No soil test is available which is satisfactory for nitrogen under Ontario conditions. The nitrogen recommendations for different crops on mineral and muck soils are compilations from all of the research experience in Ontario.

The phosphate and potash requirements for different crops are presented on pages 27 and 28. These recommendations and the soil tests on which they are based are approved by the Ontario Soil Management Research Committee.

Where a recent soil test is not available, a rough estimate of fertilizer requirements can be obtained from the tables on pages 27 and 28, using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the **medium** soil-test rating;
b. If the field has received little fertilizer in the past, use one of the rates recommended for the **low** soil-test rating. Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

MICRONUTRIENT TESTS

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn, the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper or iron. Tests for these elements range from rather unreliable in the case of boron to useless in the case of copper on Ontario soils. Plant analysis and visual symptoms are useful for determining boron and copper needs.

SOIL TESTS FROM OTHER LABORATORIES

Each year a number of growers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory

uses the identical chemical tests used in the OMAF laboratory and expresses their test results in the same units, the OMAF fertilizer requirements for phosphorus and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations can lead to less reliable recommendations than are now provided.

SOIL SAMPLING

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field, should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken, the more likely the soil sample will provide a reliable measure of the fertility in the field. The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well, and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. One sample should not represent more than 10 hectares. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime manure compost or crop residues have been piled.

WHEN TO SAMPLE

Each field should be sampled once every two to three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example, with crops such as potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower, and a copy sent to the county or district office of the Ontario Ministry of Agriculture and Food, within 5 working days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring-seeded crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample.

SAMPLE BOXES AND INFORMATION SHEETS

Soil sample boxes and information sheets may be obtained from any district or county office of the Ontario Ministry of Agriculture and Food or from Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario N1H 6T9.

Management practices which affect a soil test recommendation are manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

CHANGES IN CROP OR MANAGEMENT

Fertilizer requirements on the OMAF soil test report are for specific crops and management. If the crop management is changed in regard to legumes plowed down or manure applied, then adjustments in fertilizer requirements may be made using the manure and legume-sod adjustments in the table below and on page 17. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

NITROGEN ADJUSTMENT FOR LEGUMES PLOWED DOWN

When sod containing legumes such as alfalfa, trefoil and clover is plowed under, it supplies an appreciable amount of nitrogen to the following crop. The table below shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

ADJUSTMENT OF NITROGEN REQUIREMENT WHERE SOD CONTAINING LEGUMES IS PLOWED DOWN

Type of Sod	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3	0
1/3 to 1/2 legume	22
1/2 or more legume	110
Perennial legumes seeded and plowed the same year	45[1]

[1] *Applies where the legume stand is thick and over 40 cm high*

PLANT ANALYSIS

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether the nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test, so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed, since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

SAMPLING

Time of sampling has a major effect on the results, since nutrient levels with a plant vary considerably with its age. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 20 plants distributed throughout the area chosen for sampling. Each sample

should consist of at least 30 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis, take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

SAMPLE PREPARATION

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately, they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less, or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc-coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

SEWAGE SLUDGE

Land may not be used to grow vegetables within six months after sludge applications. This avoids the potential hazards associated with the presence of pathogens and, in particular, of parasitic organisms.

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most vegetable crops grow well in a soil pH range from 6.0 to 7.5 on mineral soils and from 5.0 to 6.0 on muck soils. Many vegetable crops grow well on mineral soils above pH 7.5 but micronutrient deficiences are more likely.

To correct soil acidity, ground limestone should be broadcast and worked into the soil at rates determined by soil test. The accompanying table shows the soil pH values below which lime is recommended and the "target" soil pH to which soils should be limed for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

THE BUFFER pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed, but a separate soil test, the buffer pH, is used on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH), use the Lime Requirement Table to determine the amount of lime required to reach different "target" soil pH values required for different crops.

SOIL pH AT WHICH LIME IS RECOMMENDED FOR ONTARIO CROPS

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse-and Medium-Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf, tobacco	5.6	6.0
Potatoes	5.1	5.5
Fine-Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
All crops not listed above or below	5.6	6.0
Corn, rye, grass hay and pasture, tobacco	5.1	5.5
Organic Soils (peats and mucks)		
All field and vegetable crops	5.1	5.5

**Where a crop is grown in rotation with other crops requiring a high pH (for example, corn in rotation with wheat or alfalfa), it is recommended that the soil be limed to the higher pH.*

LIME REQUIREMENTS TO CORRECT SOIL ACIDITY BASED ON SOIL pH AND SOIL BUFFER pH

Buffer pH	Target Soil* pH = 7.0	Target Soil pH = 6.5 Lime if soil pH below 6.1	Target Soil pH = 6.0 Lime if soil pH below 5.6	Target Soil pH = 5.5 Lime if soil pH below 5.1
	Ground Limestone Required — t/ha (Based on an Agricultural Index of 75)			
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

**Liming to pH 7.0 is recommended only for club-root control on cole crops.*

EXAMPLE CALCULATION OF THE FINENESS RATING OF A LIMESTONE

Particle Size	% of sample		Effectiveness factor		
Coarser than No. 10 sieve*	10	x	0.0	=	0
No. 10 to No. 60 sieve	40	x	0.4	=	16
Passing through No. 60 sieve	50	x	1.0	=	50
			Fineness Rating	=	66

**A No. 10 sieve has wires spaced 2.0 mm. and a No. 60 sieve spaced 0.25 mm apart.*

LIMESTONE QUALITY

Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less, as it is an excellent inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Two main factors effect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone, and hence it neutralizes acidity much more slowly — so slowly that it is of little value.

The calculation of a fineness rating for ground limestone is illustrated in the accompanying table.

THE AGRICULTURAL INDEX

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index".

$$\text{The Agricultural Index} = \frac{\text{neutralizing value x fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the Ontario soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\text{Limestone application rate from soil test report} \times \frac{75}{\text{Agri. Index of your limestone}} = \text{Rate of application of your limestone}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 9 x 75/90 = 7.5 t/ha.

[1] *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

LIQUID LIME

"Liquid lime" is advertised and occasionally sold in Ontario, often at very high costs in relation to the neutralizing value. This is very fine ground limestone suspended in water. It is equivalent to finely ground dry lime in availability and would have a "fineness" rating of 100. When diluted with water neutralizing value will be low per unit of weight, resulting in the need for high rates of application. Note that in the fineness rating lime passing through a 60 mesh screen is considered to be 100% effective. Limestone ground finer than this is not considered to be any more effective.

TILLAGE DEPTH

Lime recommendations presented here raise the pH of the top 15 cm (6 inches) of a soil to the listed target pH. If the soil is plowed to a greater depth than 15 cm, proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils, it should be incorporated to 15 cm depth where practical.

LOWERING SOIL pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate. If the soil pH is above 7.0, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

SOIL ACIDIFICATION TO pH 5.0 WITH SULFUR

	Soil Type			
Initial pH	**Sand**	**Sandy loam**	**Loam**	**Clay loam**
7.0	9*	11	14	17
6.5	8	9	11	14
6.0	6	7	8	11
5.5	3	4	5	8

**kg of elemental sulfur per 100 m² for 2 successive years*

FERTILIZER ANALYSES AND BLENDS

The Ontario Soil Management Research Committee recommends fertilizers on the basis of the nutrient requirements shown by research and soil tests. In some situations traditional fertilizer ratios will meet the combined requirements for nitrogen, phosphate and potash. Most fertilizer dealers can produce blends which meet the needs of the crop, as indicated by soil tests.

FERTILIZER MATERIALS

Nitrogen fertilizers are available in dry, liquid and gaseous forms. Which of these forms to use is a matter of choice for the individual vegetable grower, depending upon availability of the material, equipment for handling, cost per kilogram of nitrogen, the cost of application and grower preference.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen, not kilograms of materials, are used. The table on page 23 shows the percentage of fertilizer nutrient contained in different materials.

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient; (2) differences in solubility of the salts in the soil; and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia or boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in the soil solution at any one time is very low.

NUTRIENTS IN FERTILIZER MATERIALS

Nitrogen Materials	Form	% Nitrogen (N)*
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid**	20
Ammonium nitrate-urea (UAN)	Liquid	28
Ammonium nitrate-urea (UAN)	Liquid	32
Ammonia-ammonium nitrate-urea	Liquid**	41
Ammonia-ammonium nitrate	Liquid**	41
Anhydrous ammonia	Liquid**	82
Phosphate Materials	**% Phosphate (P_2O_5)***	
Superphosphate	18 to 20	
Triple superphosphate	44 to 46	
Monoammonium phosphate (MAP)	48 to 52	
Diammonium phosphate (DAP) 18-46-0	46	
Potash Materials	**% Potash (K_2O)***	
Muriate of potash	60	
Sulfate of potash	50	
Sulfate of potash-magnesia (11% Mg)	22	
Potassium nitrate (13-0-44)	44	

* *Kilograms of N, P_2O_5 or K_2 supplied in 100 kilograms of materials.*
*******Liquid under pressure.*

SOLUBLE SALTS IN FARM SOILS

High concentrations of water soluble salts in soils can prevent or delay germination of seeds and can kill established plants or seriously retard their growth.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Soluble salts in soils can result from excessive applications of fertilizers and manures, runoff of salts applied to roads, and chemical spills on farm land. High concentrations of soluble salts in or near a fertilizer band can cause serious temporary problems, affecting seed germination and/or early plant growth without seriously affecting the salt concentrations in the remainder of the soil. A given amount of salt in a soil provides a higher salt concentration in soil water if the amount of water is small. Soluble salts also interfere with the uptake of water by plants. For these reasons plant growth is most affected by soluble salts in periods of low moisture supply (during drought periods).

Soluble salts can be measured readily in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water soluble salts, the higher the conductivity. The following table provides an interpretation of soil conductivity readings as read in Ontario field soils in a 2:1 water: soil paste, the procedure used by the OMAF soil testing service.

Soil Conductivity Reading Interpretation

Conductivity "salt" reading millisiemens/cm	Rating	Plant Response
0-0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26-0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46-0.70	H	May reduce emergence and cause slight to severe damage to salt-sensitive plants.
0.71-1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

For greenhouse soils, the OMAF soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method, conductivity readings up to 3.5 millisiemens/cm are acceptable.

1. **Nitrogen Fertilizers**

   Ammonium nitrate, monoammonium phosphate and ammonium sulfate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea.

   Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

   Anhydrous ammonia and aqua ammonia are extremely toxic fertilizers and should not be applied near seeds unless applied at least one week before seeding. Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

2. **Phosphate Fertilizers**

   Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of vegetable crops.

   Diammonium phosphate is more toxic than other phosphate fertilizers — see under nitrogen fertilizers.

3. **Potash Fertilizers**

   Muriate of potash (KCl) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

   Sulfate of potash (K_2SO_4) is less toxic than muriate of potash.

   Sulfate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

   Potassium nitrate is one of the safer sources of potassium when considered as a nitrogen source as well.

4. **Fertilizers Containing Micronutrients**

   Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients, and maximum safe rates should be reduced. Boron is particularly toxic.

FERTILIZER PLACEMENT

Phosphorus is most important for early growth and is more available if placed near the seed. For transplant crops, the use of high-phosphorus starter solution is a profitable practice.

Nitrogen fertilizers readily dissolve in the soil water and move easily through the soil to the plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirements is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. Much of the nitrogen is not applied until side-dressing in order to conserve the fertilizer from leaching or to restrain plants from too much vegetative growth.

Too much potassium applied in a band at planting or in the transplant water can injure young seedlings and reduce crop yield and quality. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On the coarse-textured sands and sandy loams, part of the potassium fertilizer requirements should be broadcast and worked into the soil before planting.

STARTER SOLUTIONS

Water-soluble fertilizers (e.g., 10-52-10) and liquid fertilizers (e.g., 6-24-6 and 10-34-0) are used as starter solutions at planting time to stimulate the growth of young transplants.

Vegetable crops will benefit if starter solutions are used in the planting water when the young transplants are set in the field.

SIDE-DRESSING

The purpose of side-dressing is to supply additional nutrients during growth of the crop. Most commonly, nitrogen is the nutrient that is supplied after the plant has reached a certain stage of development. With crops that produce fruit (e.g., peppers or tomatoes), it is important not to have too much vegetative growth early in the season, or flowers will not develop, or may drop off if they do develop. For this reason, it is usually advisable to put only a moderate amount of nitrogen in the soil at the time of seeding or planting. After the plant has set some fruit and is no longer in danger of becoming too vegetative, extra nitrogen can be applied. The timing and amount of nitrogen side-dressing must be judged from the appearance of the plants. On coarse, sandy soil it may be advisable to add potash as well as nitrogen.

FERTILIZER THROUGH THE IRRIGATION SYSTEM

Many fertilizers, particularly nitrogen, may be applied through the irrigation system during the growing season. In some crops it is difficult to move along the rows with side-dressing machinery without damaging the plants, whereas the irrigation water will penetrate fairly evenly over the whole area without damaging the plants. Additional information is given on page 31 under Irrigation.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is 6.0 or lower, the most effective means of supplying magnesium is by application of dolomitic limestone. If the pH is above 6.0, magnesium can be supplied by either magnesium sulfate or sulfate of potash-magnesia. These latter sources of magnesium are usually quite expensive compared to supplying magnesium from dolomitic limestone.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason, it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low-magnesium soils.

A magnesium deficiency may occur on carrots, celery, tomatoes and spinach. The usual symptom is yellowing of the older leaves while the veins remain dark green. Magnesium deficiency in celery may be caused by a genetic abnormality in which the plant is unable to obtain magnesium from the soil. Potato plants become lighter in colour.

MICRONUTRIENTS

Micronutrient elements should not be combined with insecticide or fungicide sprays unless the manufacturer's directions indicate that this may be done or experience has shown they are compatible.

Micronutrient elements should be applied only on competent advice or where experience has proven their application to be necessary. Soil or foliar applications can be made. Soil applications are generally made at soil-preparation time and foliar applications are applied during the growing season. A sticker spreader should be included in micronutrient sprays.

Boron. A lack of boron causes a breakdown of the young tissue with slow growth, tissue cracking, blackening, and misshapen plants. In addition, the leaves of beets and spinach become twisted with light spots on the petioles. Internal breakdown (internal black spot) may occur in the roots or may appear on the root surface as external cankers. Broccoli and cauliflower show leaf rolling and deformed buds, hollow stems, and the heads turn brown. Cabbage develops internal dead spots and hollow stems. Corn kernels fail to develop at the tip of the cob and the ears are barren. Celery petioles show reddish-brown spots (cat-scratches). Rutabagas develop water-soaked areas (water-core) internally.

Because boron is needed only in very small quantities, and since an overdose is toxic, extreme care should be taken in its use. Continued applications should be made only on expert advice. Application of boron to mineral soils has not been universally successful; foliar sprays have generally given faster and more effective results. Spray when the young plants are about 8 cm high. A second application may be required. On request, boron fertilizers may be mixed with ordinary fertilizers by manufacturers.

Copper. Copper-deficient lettuce leaves lose their firmness (rabbit-ear), become chlorotic, and the plants become bleached on the stems and leaf margins. Onions produce thin, pale yellow scales which cause poor colour and keeping quality. A lack of copper also causes poor colour in carrots.

Copper deficiency seldom occurs in the mineral soils of Ontario; however, copper sulfate should be used for at least three years on new muck soils. Further applications should be made as suggested by experience and experimental evidence.

Soil-applied fertilizer copper has recently been shown to have the residual effect of slowing down the undesirably rapid degradation and subsidence of cultivated muck soils (see page 16).

Extreme care is necessary using foliar sprays with copper sulfate, because injury to the foliage may occur readily. Competent advice in the use of copper sprays is necessary.

Manganese. The general symptoms of manganese deficiency are interveinal chlorosis of leaves which begins in the younger foliage. Later the whole plant may be affected. A russetting, curling and dwarfing of the foliage occurs in beets. Other crops susceptible to manganese deficiency are beans, carrots, onions, celery, and tomatoes. Spray applications have proven more effective than soil applications. Apply sprays when the plants are about one-third grown, or sooner if this deficiency is identified. Two or more sprays may be necessary at 10-day intervals to correct the deficiency.

Molybdenum. Deficiency symptoms on cauliflower and broccoli start with cupping of the leaf margins and interveinal chlorosis of the younger leaves. As the leaves develop, twisting of the midrib and irregular development of the leaf tissue cause a strap- or whip-like appearance (whiptail). The early symptoms of molybdenum deficiency in other crops are similar to nitrogen deficiency. Later symptoms are interveinal mottling of leaves with chlorotic areas becoming puffy, marginal cupping and scorching of leaves, twisting and distortion of younger leaves.

This deficiency occurs more often on sandy, acid soils; however, it may occur even in neutral soils if soil-molybdenum reserves are depleted by heavy cropping. Molybdenum availability to plants increases with an increase in pH, and differs from the other trace elements. Consequently, liming acid soil may be a good practice to overcome molybdenum deficiency. Molybdenum can also be applied in the transplanting water at the rate of 30 to 40 g of sodium molybdate per 100 L of water, each plant receiving 0.3 L of this solution.

SECONDARY AND MICRONUTRIENT RECOMMENDATIONS

The following secondary and micronutrients may be deficient on some Ontario soils. To prevent foliar sprays from being toxic to the plant, do not exceed the recommended concentration. The spray should be sufficient to wet the foliage. In some cases more than one application may be necessary.

	APPLICATION RATE					
	Soil*			%	Foliar	
Nutrient	Nutrient kg/ha	Product kg/ha	Source	Composition	Nutrient kg per 1000 L	Product kg per 1000 L
Calcium (Ca)**	—	—	Calcium Chloride	36% Ca	1.9	5.0
	—	—	Calcium Nitrate	19% Ca	1.9	10.0
Magnesium (Mg)	120-260	2 t/ha	Dolomitic Limestone	6-13% Mg	—	—
	30	300	Epsom Salts	10.5% Mg	1.9	18
	30	300	Sulphate of Potash-Magnesia	11% Mg	—	—
Boron (B)	1.0-3.0		Various Materials Available	12-14.3% B	—	—
			Solubor	20% B	0.1-0.3	0.5-1.5
Copper (Cu)	7.0-14.5	28-60	Copper Sulfate	25% Cu	0.5-1.5	4-12
	—	—	Copper Chelates	5-13% Cu	0.5-1.5	—
Manganese (Mn)***	—	—	Manganese Sulfate	28% Mn	0.5-1.0	1.8-3.6
	—	—	Manganese Chelates	5-12% Mn	0.5-1.0	—
Molybdenum (Mo)	—	—	Sodium Molybdate	39% Mo	0.1-0.25	0.25-0.6
Zinc (Zn)	4-12	11-33	Zinc Sulfate	36% Zn	0.6	1.6
	4-12	—	Zinc Oxysulfate	18-36% Zn	—	—
	—	—	Zinc Chelate	9-14% Zn	0.6	—

**Double rates for muck soil, except dolomitic limestone.*
***For blackheart of celery.*
****For onions use 1.5 to 2.75 kg Mn/1000 L.*

CAUTIONS

(1) Because of the danger of burning leaf tissue, do not mix more than one micronutrient at a time. Do not spray under hot, humid conditions. It is very rare that more than one micronutrient is deficient at one time.

(2) Do not spray less than 200 litres per hectare.

(3) Micronutrient chelates are generally no more effective than water soluble inorganic sources when used as a foliar spray. Be sure you use enough. If sufficient quantity is used to be effective, the cost is quite high.

PHOSPHORUS REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — PHOSPHATE (P_2O_5) REQUIRED — kg/ha

Phosphorus Soil Test ppm P in soil	Rating	Beans (lima) Beans (snap) Peas	Radish	Sweet corn Established asparagus	Beet Carrot Lettuce Onion Parsnip Rutabaga Spinach	Potato	Cucumber Muskmelon Pumpkin Squash Tomato* Watermelon	Celery Rhubarb	Broccoli* Brussels sprouts** Cabbage** Cauliflower** Eggplant* Pepper* Asparagus (nursery and new plantings)
0-3		80	80	110	180	200	230	230	270
4-5		60	70	100	170	200	230	230	260
6-7	LOW	50	60	90	170	190	220	220	250
8-9		40	60	70	160	190	220	220	240
10-12		30	50	50	160	180	210	220	230
13-15	MEDIUM	20	50	20	150	170	190	210	220
16-20		0	40	20	140	160	170	190	200
21-25	HIGH	0	40	0	120	140	140	160	170
26-30		0	30	0	100	120	110	140	140
31-40		0	30	0	80	90	80	110	110
41-50	VERY HIGH	0	20	0	50	50	50	80	80
51-60		0	0	0	30	30	30	50	50
61-80		0	0	0	0	30	0	0	0
80+	EXCESSIVE	0	0	0	0	30	0	0	0

* *For transplanted tomatoes, peppers and eggplants, apply a starter solution, such as 1 L of 10-34-0 per 100 L water, or 1 L of 6-24-6 per 75 L at planting.*

For transplanted broccoli, Brussels sprouts, cabbage and cauliflower, if no insecticide is used in the planting water, apply a starter solution high in nitrogen such as 20-20-20 at 1 kg/200 L. Under high temperatures and in dry, sandy soils use half the concentration of fertilizer.

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

POTASSIUM REQUIREMENTS — VEGETABLES ON *MINERAL* SOILS — POTASH (K_2O) REQUIRED — kg/ha

Potassium Soil Test ppm K in soil	Rating	Radish	Beans (lima) Beans (snap) Peas	Sweet corn	Cucumber Muskmelon Pumpkin Squash Watermelon	Beet Carrot Lettuce Onion Parsnip Potato Spinach	Broccoli Brussels sprouts Cabbage Cauliflower Eggplant Pepper	Celery Rhubarb Rutabaga*	All Asparagus	All Tomatoes*
0-15		60	120	170	230	230	270	340	420	660
16-30		60	110	160	220	220	250	330	400	640
31-45	LOW	50	90	140	200	210	230	310	360	600
46-60		50	80	110	180	190	200	280	320	560
61-80		40	60	60	140	160	170	250	280	480
81-100		30	40	40	100	130	130	200	250	400
101-120	MEDIUM	30	30	30	70	100	100	150	220	340
121-150		20	0	0	50	80	80	90	190	300
151-180		20	0	0	40	50	50	50	160	280
181-210	HIGH	0	0	0	0	0	0	0	130	140
211-250	VERY HIGH	0	0	0	0	0	0	0	0	70
250+	EXCESSIVE	0	0	0	0	0	0	0	0	0

* *For rutabagas and tomatoes on soils with magnesium tests less than 100, the required amount of potash is adjusted downward from the amounts shown in this table to a minimum of 50% at 50 ppm Mg.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

PHOSPHORUS AND POTASSIUM REQUIREMENTS — VEGETABLES ON *MUCK* SOILS

Phosphorus Soil Test	Rating	Beet, Broccoli, Brussels sprouts, Cabbage, Carrot, Cauliflower, Lettuce, Onion*, Parsnip, Potato, Radish, Spinach	Celery
ppm P in soil		Phosphate (P_2O_5) required kg/ha	
0-3		100	120
4-5		100	120
6-7	LOW	100	120
8-9		100	120
10-12		90	120
13-15		90	110
16-20	MEDIUM	80	100
21-25		70	90
26-30		60	80
31-40		**50**	**70**
41-50	HIGH	**30**	**50**
51-60	VERY HIGH	20	40
61-80		0	0
80+	EXCESSIVE	0	0

Potassium Soil Test	Rating	Broccoli Brussels sprouts Cabbage Cauliflower	Carrot Celery Onion Parsnip Potato	Beet Lettuce Radish Spinach
ppm K in soil		Potash (K_2O) required — kg/ha		
0-15		200	230	100
16-30		190	220	100
31-45	LOW	170	210	90
46-60		150	200	80
61-80		120	170	60
80-100		90	150	40
101-120	MEDIUM	70	120	30
121-150		50	80	20
151-180		40	40	20
181-210	HIGH	**0**	**0**	**0**
211-250	VERY HIGH	0	0	0
250+	EXCESSIVE	0	0	0

** If maturity of onions is a problem on organic soils less than 40 cm deep, additional phosphate may be required.*

The fertilizer rates in this table are designed to produce highest economic yields when accompanied by good or above-average management.

DEER AND RABBIT CONTROL

Both deer and rabbits can be a serious problem in vegetable plantings particularly in areas where woodlots or other brush surround vegetable fields. Deer will often root for carrots in harvested fields.

Hinder is registered as both a deer and rabbit repellent. It can be applied using normal field spraying equipment. The rate to use is dependent on the severity of the problem. Hinder, at 2 to 4 litres per 100 litres should be applied at a volume of 450 to 950 litres of water per hectare. This results in an actual application range of 9 to 39 litres of Hinder product per hectare.

Hinder acts as a scent repellent. It is, therefore, important that the boundary margins of the affected fields, particularly areas where the deer or rabbits are entering, be thoroughly covered with spray solution.

CUTWORMS

Several species of cutworms attack vegetables. The dark-sided, redbacked, black and glassy cutworms appear early in the growing season. Depending on soil and climatic conditions, these species will attack the plants below or at the soil surface, or will feed on the foliage. Late-season damage is caused primarily by the variegated cutworm which is a foliage feeder.

Effective cutworm control is dependent on proper timing of insecticide applications under favourable soil and climatic conditions. The insecticides recommended for use are short-residual, and breakdown quickly in sunlight. Also, most species of cutworms go into the soil during the day and come out to feed at night. Thus, insecticide applications should be made in late afternoon or early evening when temperatures are lower and just prior to the time the insects come up to feed. The insecticides are also more effective on moist soil as compared to dry soil.

Note: The insecticides recommended are not registered on all crops. Consult the label to determine registration on a specific crop, the preferred methods and rates of application, and the required interval between application and harvest, or request advice from your nearest Pest Management Advisor or Horticultural Crop Advisor.

The following control programs can be used:

A. **Early-Season Species of Cutworms:**

1. Preplanting cover-crop treatment: Five days before plowing under the rye or wheat cover crop, when it is 10 to 15 cm high, apply chlorpyrifos (Lorsban 4E) once in 200-400 L of water per hectare. Applications should also be made to fencerows and to a 15-m strip of any nearby cover crop.

2. Preplanting soil treatment: Apply chlorpyrifos (Lorsban 4E) once in 200-400 L of water per hectare as a broadcast soil-surface application. **Do not incorporate on muck soils.**
   NOTE: Where there has been a history of cutworm damage, 1 and 2 are the preferred methods of treatment. Preplanting treatments will not be phytotoxic to vegetable crops.
3. Postplanting treatment: When cutworm damage first becomes apparent apply either:
   (a) chlorpyrifos (Lorsban 4E)
   or
   (b) permethrin (Ambush 500 EC). Use higher rates of permethrin on dry and muck soils and when cutworms are large (2.5-4 cm long).
   or
   (c) cypermethrin (Ripcord 400 EC)
   Use sufficient water for good coverage (200-500 L/ha). DO NOT DISTURB the soil for at least 5 days after treatment.

   NOTE
   (1) Chlorpyrifos, permethrin and cypermethrin are effective **only** on surface-feeding stages of cutworms.
   (2) Chlorpyrifos, permethrin and cypermethrin are registered **only** for use on seedlings (up to 5-leaf stage) and/or transplants.
   (3) Chlorpyrifos may be phytotoxic to some varieties of plants under stress conditions, i.e. hot dry weather or cool, excessively wet weather.

B. **Late-Season Species of Cutworms:**
When cutworm damage first appears, apply carbaryl, [1]methomyl or permethrin in sufficient water for good coverage of foliage. Spray penetration of the foliage canopy is essential for good cutworm control. Best control will be obtained when cutworm larvae are small.

[1] *Minimum period before re-entry is 24 hours.*

CUTWORMS

Product	Crop	Rate
Ripcord 400	Carrots	175 mL/ha (21 days)
	Cole Crops	175 mL/ha (21 days)
	Lettuce	175 mL/ha (21 days)
	Onions	175 mL/ha (21 days)
	Potatoes	175 mL/ha (7 days)
Lorsban 4E	Broccoli	1.2-2.4 L/ha (32 days)
	Brussels Sprouts	1.2-2.4 L/ha (32 days)
	Bulb Onion	1.4-4.8 L/ha (60 days)
	Cabbage	1.2-2.4 L/ha (32 days)
	Carrots	2.4-4.8 L/ha (60 days)
	Cauliflower	1.2-2.4 L/ha (32 days)
	Celery	1.2-2.4 L/ha (70 days)
	Chinese Cabbage	1.2-2.4 L/ha (32 days)
	Cucumber	1.2-2.4 L/ha (60 days)
	Garlic	1.2-2.4 L/ha (50 days)
	Green Pepper	1.2-2.4 L/ha (40 days)
	Potato	1.2-2.4 L/ha (7 days)
	Rutabaga	1.2-2.4 L/ha (30 days)
	Sweet Corn	1.2-2.4 L/ha (70 days)
	Tomato	1.2-2.4 L/ha (70 days)
Ambush 500 EC*	Asparagus	140 mL/ha (2 days)
	Beets	140 mL/ha (up to 5 leaves)
	Broccoli	140 mL/ha (7 days)
	Brussels Sprouts	140 mL/ha (3 days)
	Cabbage	140 mL/ha (3 days)
	Carrots	140 mL/ha (up to 5 leaves)
	Cauliflower	140 mL/ha (3 days)
	Lettuce	140 mL/ha (up to 5 leaves)
	Onion	140 mL/ha (up to 5 leaves)
	Peas	140 mL/ha (up to 5 leaves)
	Pepper	140 mL/ha (1 day)
	Potato	140 mL/ha (1 day)
	Tomato	140-200 mL/ha (1 day)

* *Rates for crops grown on muck soils may vary. Check the label.*

Sevin XLR Plus*	Asparagus	2.5-6.4 L/ha (2 days)
	Cucumber	2.25 L/ha (5 days)
	Melons	2.25 L/ha (5 days)
	Pumpkins	2.25 L/ha (5 days)
	Squash	2.25 L/ha (5 days)
	Sweet Corn	5.25 L/ha (1 day)

* *Late season climbing cutworms only.*

Lannate L*[1]	Potatoes	1.25-2.25 L/ha (3 days)
	Tomatoes	1.25-2.25 L/ha (1 day)

* *Late season climbing cutworms only.*
[1] *Minimum period before re-entry = 24 hours.*

CHEMICAL SEED TREATMENT

All vegetable seed should be treated with a fungicide to help prevent seed decay and damping-off.

To control black rot in cabbage, cauliflower, Brussels sprouts, broccoli and rutabaga, treat the seed with streptomycin. Check the label for method of treating the seed and rates, etc.

To control seedcorn maggot, treat seeds of bean, corn, pea, cucumber, melon, squash and other large-seeded crops with diazinon insecticide and with lindane insecticide for wireworm control. **To avoid insecticide injury to the seed, apply insecticides only in combination with a fungicide.** The combination seed treatment containing captan or thiram and both insecticides should be used each season because not all wireworms are killed and seed maggots are usually present.

Treat seed not longer than three months before planting, with a combination lindane-diazinon-captan or lindane-diazinon-thiram.

Commercial seed dressings containing these chemicals are available. Check labels for registered crops and rates of application.

Use a combination lindane-diazinon seed treatment on seed already treated by the seed company with a fungicide or fungicide plus malathion. Although commercial seed-treating equipment gives the best coverage, seed may be treated on the farm. Mix the required amount of chemicals in 0.8 L of water and thoroughly mix it with one hectolitre of seed. Use a cement mixer or shovel. Spread out the treated seed to dry before bagging.

Alternatively, buy seed treated with a fungicide and the two recommended insecticides. Purchased seed may have been treated to control storage insects. Such treatment does not control seed maggots and wireworms in the field. Consult the tag or label on the package to see what was used to treat the seed.

WARNING

The concentration of pesticides in seed treatments are high and thus the products are quite toxic. Wear rubber gloves, full protective clothing and a respirator when treating seed. Avoid skin contact and breathing the fumes. Do not handle treated seed with bare hands. Dispose of surplus treated seed by burying it under 50 cm of soil in an area away from water supplies.

HOT-WATER SEED TREATMENT

Buy hot-water treated seed or treat seed as follows:

Place seed in cheesecloth bag of ample size; the bag should not be more than half full. Wet seed and bag with warm water. Soak cabbage, broccoli, Brussels sprouts, tomato, pepper and eggplant seed for 25 minutes in water maintained at 50°C. Then spread seed out to dry. Treat cauliflower, kohlrabi, kale, and summer turnip seed as above but for 15 minutes. Treat celery seed at 48°C for 30 minutes. *Tomato seed can be treated at 54°C for 25 minutes but must be planted within a few days. Use an accurate thermometer.

Stir the water and bags of seed continually to secure rapid penetration to heat to maintain uniform temperature in the seed lot.

* *Tomato seed can be treated by soaking dry seed in 3 parts of 0.6 M hydrochloric acid (i.e. mix 1 part acid with 19 parts of distilled water) for 1 hour with frequent agitation. Drain the acid, thoroughly rinse in distilled water and dry. A 0.1 M hydrochloric acid (available from scientific supply companies) can also be used to soak the seeds for 1 hour with frequent agitation and, in this case, the seeds can be dried without rinsing in water.*

DAMPING-OFF OF SEEDLINGS

Affected seedlings rot at ground level and topple over. The damping-off fungus may cause seed decay also.

Steam or fumigate used flats and soil for growing seedlings **(consult OMAF Publication 365, Greenhouse Vegetable Production Recommendations).** Treat seeds with a protectant fungicide (also see Chemical Seed Treatment). Bench tops or other surfaces used to accommodate seedling flats should be sterilized with steam, formaldehyde or other effective disinfectant; alternatively, cover bench tops with clean plastic sheeting.

Water seedlings only when necessary and preferably before noon. Provide good ventilation and keep humidity low. If damping-off appears, water flats at rate of 5 L/m², 2 or 3 times, at 4-day intervals with oxine benzoate, ferbam or thiram. Follow manufacturer's directions regarding concentration.

Where steam is used to treat soil, maintain a temperature not less than 82°C for 20 minutes throughout the soil. Avoid prolonged steaming.

Carefully follow manufacturer's directions for use of soil fumigants. Only those who have a permit may apply methyl bromide. A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto M4V 1P5, Telephone (416) 323-4321.

In time, treated soils become recontaminated by damping-off fungi. This can be delayed in flats of pepper and Spanish onion seedlings by treating the steamed soil with thiram 75 WP, 5 grams to a flat of soil, or 800g/100m² of bed. Thiram must be mixed thoroughly with the soil to a depth of 8 cm.

Disinfect used flats with steam; or immerse moistened flats in a solution of 5 L 37% formaldehyde in 125 L water, then set flats aside until the smell of formaldehyde disappears.

CROP ROTATION FOR CONTROL OF DISEASES

Crop rotation can be an important method of controlling some diseases caused by fungi, bacteria and nematodes. Rotation is effective when the organism causing the disease can only survive on the refuse and undecomposed plant matter of susceptible varieties in the soil. Rotation with a non-susceptible crop for 2-3 years usually allows enough time for plant material in the soil to completely decompose. In the absence of susceptible plant material, these organisms die off. This type of rotation works only when successive crops are not susceptible hosts. It is important to remember that plants in the same family, for example — potatoes, tomatoes, peppers and eggplant, may all be susceptible to the same disease organisms. Do not rotate with plants in the same family.

Anthracnose disease of snap beans is one example of the importance of rotation. The anthracnose fungus can only survive in the soil until the bean plant tissue has decomposed. Two years of non-host crops which the bean anthracnose fungus cannot attack will "starve out" the organism. Because the fungus can survive on bean trash and straw, these should not be spread on fields intended for snap beans within the next 2-3 years.

Other examples of diseases where crop rotation is effective are: corky root rot of lettuce, black rot of crucifers, root rot, wilt and near wilt of peas, and Sclerotinia diseases.

Some diseases can be controlled by rotation, but have such a long period of rotation — 10 to 12 years for onion smut and 7 years for cabbage yellows — that rotation is not practical. In many diseases caused by Verticillium or Fusarium, rotation will reduce the population of disease organisms in the soil but these organisms will not be eliminated because they can survive for long periods of time in the absence of host plant material.

Diseases that are spread by wind or by insects are generally not controlled by rotation. Many leaf blight organisms and powdery mildew fungi can blow into fields from neighbouring weeds and fields that are infested. Virus diseases that are spread by aphids, bacterial wilt of cucumbers spread by the cucumber beetle and aster yellows which is spread by leafhoppers, cannot be controlled by rotation.

When considering rotation as a means of disease control, check with your local OMAF specialists to make sure that it will be effective for the problem at hand.

GROWTH REGULATORS

Chemical growth regulators are recommended and used to effectively control certain plant-growth processes, and thus aid crop production and storage. When used at different rates and different stages of crop growth, they modify various stages of plant growth from germination to fruit ripening, and also the storage of harvested products.

Thus, it is important to apply the recommended rate at a precise stage of crop growth. Growth regulators are presently used in forcing rhubarb, for ripening of tomatoes, and for sprout inhibition in stored beets, carrots, onions and potatoes. **Read the label carefully before using any growth regulator.**

IRRIGATION

Most vegetable crops require a uniform supply of moisture throughout the growing season. The average rainfall in Ontario is 70 mm per month during the growing season. This provides only 65% of the water needed for optimum yield. Soil types differ in their ability to retain water following rainfall or irrigation. Water which is held by the soil and can be taken up by plants is called AVAILABLE SOIL MOISTURE (ASM). Sands and coarse sandy loams retain approximately 25 mm of ASM in the rooting zone of crops. Under average conditions a crop will use this moisture in 7 days, so on these soils a weekly irrigation of 25 mm of water would be required to maintain high yields. Fine sandy loams and silty loams retain 40 to 60 mm of ASM in the rooting zone. On these soils, heavier and less frequent irrigations (40-60 mm of water every 10 to 14 days) are required for optimum yields. Application of more water than is required wastes water, and can cause leaching of fertilizers and herbicides.

Different vegetable crops also vary in their response to irrigation. Shallow rooted crops such as potatoes and celery, require frequent, light irrigations. Deep rooted crops can use water from a greater volume of the soil profile thus do not require as frequent irrigation. Table 1 shows the relative rooting depths of a number of vegetable crops.

TABLE 1. CLASSIFICATION OF VEGETABLE CROPS BY ROOTING DEPTH

Shallow Rooted (down to 30 cm)	Intermediate (30 to 60 cm depth)	Deep Rooted (deeper than 60 cm)
lettuce	broccoli	asparagus
radish	cabbage	pumpkin
onion	cauliflower	winter squash
potato	cucumber	watermelon
celery	muskmelon	sweet corn
	pepper	parsnip
	tomato	
	snap bean	
	carrot	
	zucchini	

In addition, most vegetable crops have growth stages during which drought stress can severely reduce yield and quality. Irrigation is especially important during these critical growth periods, listed in Table 2.

TABLE 2. CRITICAL PERIODS FOR IRRIGATION OF SEVERAL VEGETABLE CROPS

Crop	Critical Period
snap bean	flowering, pod setting
broccoli, cabbage, cauliflower	head formation and enlargement
sweet corn	tasseling, pollination, ear filling
cucumber, muskmelon, zucchini	flowering, fruitset and development
onion	bulb formation and enlargement
eggplant, pepper, tomato	flowering, fruitset and enlargement

IRRIGATION EQUIPMENT

A number of different types of irrigation systems are available which are adapted for use in vegetable crops. The basic types of irrigation systems available are:

(a) *Hand Moved Sprinklers* — This is the least expensive overhead irrigation system, but labour cost to move the laterals through the field is relatively high. Water distribution is very uniform, but tall growing crops are not easily irrigated.

(b) *Travelling Gun Systems* — These systems are relatively expensive, but labour cost is reduced compared to hand-moved sprinklers. They are well suited to irrigating large fields and tall growing crops. Uniformity of water distribution is only fair, and is greatly affected by wind.

(c) *Centre Pivot and Lateral Systems* — These are self-propelled systems located to move through and irrigate large fields from a centrally located well or pump. These systems are expensive, but labour costs through the season are low. They are adapted for use in large, relatively level fields.

(d) *Drip Irrigation* — Drip irrigation systems consist of a series of built-in emitters in plastic tubing which is laid along the crop rows. Depending on the system, the emitters deliver from 1 to 5 litres of water per hour and are spaced 30 to 60 cm apart. Drip irrigation is usually used in combination with plastic mulch and is best adapted for use in warm-season crops such as tomatoes, peppers and vine crops. Cost of installing a drip system is relatively high, but labour cost through the season is very low. A major advantage of drip systems is that less water is required and the crop has a more uniform water supply through the season.

Growers should contact their irrigation dealer for information about cost of various systems, and design of the system to suit different crops and fields.

IRRIGATION SCHEDULING

Regardless of the type of irrigation system used, it is important to use some method of irrigation scheduling to avoid drought stress and provide water when it is most needed. There are two basic methods of irrigation scheduling:

(a) *Tensiometers* — Tensiometers are devices which measure the suction of the soil on moisture. As the soil dries out, moisture is more strongly held to soil particles, and is less available to the crop. Tensiometers can be used to determine when moisture stress occurs, and thus when irrigation should be started. Growers should consult their irrigation dealers on the use of tensiometers.

(b) *Water Budget Method* — This method uses climatic data to estimate the amount of available water lost from the rooting zone through crop use and evaporation. Crop water use is derived from percent crop cover and the evapotranspiration rate from climatic data. Further details of this method are provided in OMAF Factsheet, *Irrigation Scheduling for Tomatoes-Water Budget Approach,* Agdex 257/560.

OTHER USES FOR IRRIGATION

Irrigation systems may also be used to apply soluble fertilizers to the crop throughout the growing season (fertigation). A stock solution of fertilizer can be dissolved in a tank and introduced through a valve into the irrigation system either by suction or pressure. The fertilizer solution should be fed through the system slowly, over 10 to 20 minutes. After the fertilizer has passed through the system, continue to irrigate for 10 to 15 minutes to flush the system and wash the fertilizer off the leaves. Some minor element deficiencies, such as Boron, Manganese or Copper deficiency, may be corrected by the application of the appropriate fertilizer salts through irrigation systems. Drop irrigation systems may also be used to apply soil fumigants prior to planting the crop and for fertigation through the growing season. Sprinkler irrigation may be used for evaporative cooling of crops during hot weather and for frost protection.

NEMATODES

Root-lesion, root-knot, and sugar beet cyst nematodes are responsible for most nematode problems in Ontario vegetable crops. A crop may be attacked by the combined action of two or more kinds of nematodes. In some cases, nematodes aggravate diseases caused by fungi (e.g., root-lesion nematodes worsen Verticillium wilt of eggplants and potatoes). In potatoes, the verticillium nematode complex is involved in the potato early dying (i.e. premature death) problem.

The root-lesion nematode is widely distributed in Ontario and attacks many vegetable crops. It causes tiny, brownish, scratch-like wounds on the roots and is very destructive to such crops as celery and lettuce.

The root-knot nematode is frequently found in vegetable-producing areas, particularly in muck soils and greenhouses. These nematodes cause galls on the roots, resulting in poor plant growth that quite often shows up as patchy areas in a field. Many crops are attacked by this nematode, sometimes resulting in severe losses, particularly with carrots.

The sugar beet cyst nematode is quite destructive to table beets and spinach but other root and cruciferous crops are also affected. It is frequently found in association with rhubarb. This nematode can be seen on the roots as tiny, white or brown, pearl-shaped objects.

The bulb and stem nematode, which causes onion bloat, has been reported from several of the onion-growing marshes. Onion bloat symptoms may appear early in the crop when leaves become twisted and deformed. Infected plants which survive are usually deformed, with shorter, thickened leaves. Splitting and cracking of infected bulbs is one of the most easily recognizable symptoms. Practical control measures depend largely on the limited host range of the Ontario population of this nematode as well as sanitation and soil fumigation. For additional information, **see OMAF Factsheet, *Bulb and Stem Nematode*, Agdex 253/628,** or your local Horticultural Crop Advisor or Pest Management Advisor.

Nematode problems are often difficult to diagnose and to control. Commercial growers are advised to consult the Horticultural Crop Advisor or Pest Management Advisor in their area if a nematode problem is suspected.

Steam sterilization of greenhouses is still a very effective means of controlling nematodes, although chemical fumigation has become a common practice with many growers.

In the field, a program of crop rotation with periodic soil fumigation is recommended. Consult your Horticultural Crop Advisor or Pest Management Advisor, or the Research Station, Agriculture Canada, at Vineland Station, concerning crop-rotation programs for individual crops. For additional information on nematode diagnosis, refer to the OMAF Factsheets listed on pages 81 and 82, etc.

The chemicals most commonly used in preplant soil fumigation for nematode control are Telone II, Telone C-17, and Vorlex Plus. In Ontario, much of the soil fumigation against nematodes is done by custom operators. Recommended rates are usually indicated as a range, e.g., 110-220 L/ha. Use a level near the upper limit for muck soil. Always follow manufacturers directions carefully concerning rate and methods of use.

Soil fumigation can be done either in the fall or in the spring. Most growers prefer to fumigate in the fall to avoid delays in planting in the spring.

At the time of fumigation, the soil temperature should be at least 4°C at the 15-cm depth, the soil must be thoroughly worked to a depth of 20 to 25 cm and the moisture content of the soil must be at a level that would permit good seed germination. With fall applications, the soil should be worked several weeks before fumigation so that the area is reasonably free from undecomposed crop residue. For a copy of the publication ***Land Preparation — A Key to Successful Soil Fumigation,*** contact Nematology Section, Research Station, Agriculture Canada, Vineland Station L0R 2E0.

The soil surface must be sealed immediately after injection by floating, packing or a water seal, and left undisturbed for one week, or longer if the weather is wet and cool. Before planting, till the soil thoroughly to aerate, and ensure that all traces of fumigant odour have dissipated. With fall applications, the soil should not be disturbed after sealing until the normal spring cultural operations are started.

Methylbromide, and at high rates Vapam and Vorlex, are used as general-purpose soil fumigants. Do not use nematicides containing bromine before planting onion, garden beet, celery and potato. Methylbromide must be applied under a plastic cover according to the manufacturers directions.

Only those who have a permit may apply methylbromide. A permit may be obtained from Pesticides Control Section, Ministry of the Environment, 135 St. Clair Avenue West, Toronto, Ontario M4V 1P5, telephone (416) 323-4321.

SLUGS

Metaldehyde is specific for slug control. Most other chemicals have little effect on them. Slug baits, dusts and sprays containing metaldehyde are registered for use in Canada, but in Ontario the slug bait appears to be the only one widely distributed.

WHITE GRUBS

To avoid injury by white grubs, do not plant vegetables on land that has been in grass sod for two or more years.

WIREWORMS

Wireworms are more likely to be a problem for the first two years following sod. There are two control programs:

(a) **Seed Treatment:** For large-seeded vegetables (beans, etc.) use a lindane seed treatment.

(b) **Broadcast or band soil treatment:** This treatment is necessary for potatoes. Use one of the following:

1. carbofuran
   Furadan 10 G 32.5 kg/ha (band treatment only)
2. fonofos
   Dyfonate 10 G 55 kg/ha

Immediately after application to the soil surface cultivate to a depth of 10 to 15 cm, or drill directly into the soil at planting time (consult the label).

ASPARAGUS

CULTIVARS
(Revised for 1992)

Jersey Giant	Jersey Centennial

GROWING SEEDLINGS

Soak seed in water about 32°C for 3 to 4 days. Dry and sow immediately in early spring in fertile, well-prepared soil. Plant seed 2.5 to 4 cm deep and 8 to 10 cm apart in rows 45 to 60 cm apart. One kilogram of good seed should provide enough crowns to plant one hectare. Plan to grow more plants than is needed, to allow for selection of strong plants. Date of seeding is the last two weeks of May. Sow 11 kg of seed per hectare (approximately 250,000 crowns per hectare). Keep weeds and grasses controlled at all times.

FIELD SELECTION AND PREPARATION

Asparagus is a **long-term** vegetable crop which should produce viable yields for fifteen or more years. Therefore, thorough planning is essential for success. Field selection and preparation are key to good long-term production. **Plant only into well-drained sandy or sandy loam soil free of perennial weeds and grasses.** Eradication of perennial weeds and supplemental drainage improvement must be completed before the year of transplanting.

Soil testing is highly recommended to determine fertility levels and pH before transplanting.

Ideal soil pH should range between 6.0 and 6.8.

If possible, seed a green-manure crop the year before transplanting to increase soil organic matter. Livestock manure can also be used.

TRANSPLANTING AND SPACING

In early spring dig the one-year plants, discard the weak or small crowns (less than 20 grams). Up to one-half of the total crowns may be discarded. Plant the others in furrows so that the tops of the crowns are 15 cm deep. Space the plants 22 to 30 cm apart in rows 1.2 to 1.5 m apart. Spread out the roots and cover with not more than 5 cm of well-firmed soil. Fill in furrows gradually by cultivating as plants grow. **Control weeds to retain high plant populations and vigorous growth.**

TILLAGE AND FERN DISPOSAL

It is best to retain asparagus fern all winter in order to trap the snow and thereby protect the crowns from low-temperature winter injury. The fern can be cut up with a rotary or flail-type mower before **minimum and light disking in early spring.** The fern contributes organic matter to the soil. **Use minimum cultivation for fern disposal and weed control. Excessive and deep tillage can injure crowns which can increase Fusarium infection and reduce yields. Use zero tillage where suitable.**

HARVEST OF SPEARS

Most asparagus plantings are vigorous enough so that they can be harvested for about 10 to 14 days in the spring of the third year after field setting **(i.e., field set spring 1990, first limited harvest spring 1992).** If asparagus **vigour** has been reduced by weed competition, insects or disease, or any other stress factor, harvest should be delayed to the fourth year after field setting. A **4-week harvest** can then be undertaken.

An established asparagus planting is usually harvested for approximately 6 weeks. Harvesting should be terminated sooner if the emerging spears are too thin to meet the grade standards.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements **(See pages 27 and 28).** Take the soil sample at the depth of planting.

NITROGEN — For asparagus seeded in a NURSERY, apply up to 75 kg N/ha. For NEW PLANTINGS of crowns and ESTABLISHED plantings apply up to 110 kg N/ha.

APPLICATION — For the NURSERY, broadcast the N with all of the phosphate and potash required and work in before seeding. An additional 50 kg N/ha may be applied as a side-dress application in August or early September if rainfall is excessive. For NEW PLANTINGS, broadcast all of the N with the potash pre-planting. All of the phosphate should be banded below the crowns at planting. If a green-manure crop is planted in the previous year, apply 30 to 40 kg N/ha and as much phosphate and potash as that crop requires, based on soil tests, before or at seeding. If manure is applied or legume sod is **plowed** down, reduce the nitrogen application **(see Tables in pages 17 and 19).** For ESTABLISHED plantings, apply one-half of the N with all of the phosphate and potash required, broadcast, in early spring. Broadcast the remainder of the N immediately after harvest.

DISEASE CONTROL

RUST — All commercial cultivars are susceptible to rust. Disease control is achieved only with thorough spray coverage on a regular preventive schedule. This spray must protect new foliage as it grows, before rust spores can land on it and germinate. Start spraying new, non-harvested plantings as soon as growth is about 30 cm high (late May). For harvested plantings, begin spraying as soon as fern growth commences after harvest is complete. A 7- to 10-day schedule is essential until at least late August to protect the fern growth. A high-boy sprayer with drop arms having three nozzles per row is needed for full spray coverage.

Spray with one of:

1. zineb
   (i) Zineb 80 WP 2.5-2.75 kg
2. metiram
   (i) Polyram 80 DF 2.25-3.25 kg

Use high rate on full grown fern.

BOTRYTIS — This disease attacks plants which are damaged from rust or beetle feeding. Under wet weather conditions it can cause serious plant injury. A regular spray program for rust,

ASPARAGUS (Continued)

and good control of beetles before serious feeding occurs, is the best control recommendation.

FUSARIUM DISEASES — Avoid replanting on land which previously grew asparagus. Otherwise, fumigate soil with Vorlex 0.6 L per 10 m^2 before planting. Consult manufacturer's directions.

Follow all safety precautions.

Use treated seed when establishing seed beds.

Use vigorous one-year-old crowns when transplanting.

Care should be taken to avoid stresses as these make asparagus more susceptible to Fusarium diseases, and reduce the longevity of the planting.

Stresses which promote these diseases are overpicking, or picking before crowns are well established; insect and other disease damage; weed competition; excessively deep tillage; poor soil drainage; soil compaction; acidic soil pH; drought; injury from misapplication of pesticides, fertilizers, manure; and low fertility.

Consult OMAF Factsheet, *Diseases of Asparagus*, Agdex 254/635.

INSECT CONTROL

ASPARAGUS BEETLES — Because there are several generations of these beetles, they are a **constant threat** throughout the season. Begin spraying when adult beetles are observed **before** egg laying in the spring.

Spray with one of:

1. deltamethrin
   (i) Decis 2.5 EC 400 mL (post-harvest use only)
2. cypermethrin
   (i) Cymbush 250 EC 140 mL (1 day)
3. carbaryl*
   (i) Sevin XLR Plus 2.5-6.4 L (2 days)
   Use only during harvest; not during fern growth period.
   **See note on Bee Warning*
4. methoxychlor
   (i) Methoxychlor 50 WP 3.25 kg (3 days)
   (ii) Methoxychlor 25 EC 3.8-8.5 L (3 days)
5. malathion
   (i) Malathion 500 EC 2.75 L (1 day)
   (ii) Malathion 25 WP 4.5 kg (1 day)
6. rotenone
   (i) Rotenone 5% WP 6 kg plus spreader (1 day)

CUTWORMS — Apply when cutworm damage first becomes apparent.

1. carbaryl
   (i) Sevin XLR Plus 2.5-6.4 L (2 days)
2. permethrin
   (i) Ambush 500 EC 140 mL (2 days)

Also see page 28.

APHIDS — Sprays for aphids should be applied at three- to four-week intervals as needed until defoliation in October. For immature asparagus, begin application mid-May. For mature asparagus, begin application July 1, after the crop has been harvested.

Spray with one of:

1. pirimicarb
   (i) Pirimor 50 WP 1 kg in 675 L of water/ha
2. dimethoate
   (i) Cygon 480 EC 2.3 L in 675 L of water/ha
3. disulfoton
   (i) Di-Syston 720 LC 1.5 L
   (Maximum of 2 applications per year)
4. oxydemeton-methyl
   (i) Metasystox-R 240 SC 1.75-2.25 L
   (Maximum of 3 applications per year)

TARNISHED PLANT BUGS — Dimethoate, as recommended for aphids, will help control tarnished plant bug in asparagus.

PIGWEED CASEBEARER — Control pigweed completely in the planting and in headlands because if casebearers develop on pigweed they may contaminate the crop in May and early June the following year.

Consult OMAF Factsheet, *Insect Pests of Asparagus*, Agdex 254/625.

BEE WARNING

Bees are attracted to asparagus bloom. Where spraying is being done, bee poisoning may result. Dimethoate is toxic to bees and should not be used during the bloom period. Carbaryl is especially toxic to bees and should not be used during the fern-growth period. With other insecticides, losses to bees can be reduced if sprays are applied in early morning or late evening when the bees are not foraging. Advise local beekeepers of spraying activity. Your local Agricultural Representative has a list of beekeepers in your area.

STORAGE OF SPEARS

Freshly harvested asparagus is very perishable and loses quality rapidly. Collect the spears as soon as possible, protect them from the sun, and move them to cold storage, the processor or a market as soon as possible. If short-term storage is necessary, store under high humidity at 1 to 2°C. **Consult OMAF Factsheet, *Maintaining Asparagus Quality from Producer to Consumer*, Agdex 254/57.**

BEANS (SNAP AND LIMA)

CULTIVARS
(Revised for 1992)

PROCESSING — Follow processors' recommendations

FRESH MARKET

Green Bush —	Strike	Yellow Bush —	Golden Rod
	Gator Green 15		Gold Rush
	Earliserve *(trial)*		Gold Mine
	Mustang		Eureka
	Bronco		
	Wrangler	Lima —	Early Thorogreen
	Podsquad		Fordhook 242
			Mendoza Bush

SEEDING AND SPACING

Snap Beans — Green and Yellow (Wax)

Sow as shallow as soil moisture permits, usually 2.5 to 4 cm deep. Planting should begin only after soil temperature has reached 15°C. At lower temperatures, seed decay may reduce stand.

The following row spacings and seed rates are suggested for optimum yields depending on the harvest method. Seed size varies greatly between cultivars, so adjust the seeding rate by seed count.

Seeding rates must be adjusted according to germination percentage and soil temperature at planting. Increase seeding rate slightly if seeding in cool soils to compensate for reduced stands.

SPACING AND SEEDING RATES

Row Spacing (cm)	Plants Per Metre of row	Harvest Method
75 to 90	20 to 24	Hand Harvest or Mechanical
50 to 60	16 to 22	Mechanical

Lima Beans

Use 55 to 65 kg of seed per hectare. Seed approximately 4 to 5 cm deep depending on soil moisture. Rows are spaced 60 to 70 cm.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply 30-40 kg/ha prior to planting. This may be applied as a pre-plant broadcast application or banded through the planter, 5 cm below and 5 cm to the side of the seed. Sidedressing of nitrogen is only recommended following heavy rains if foliage shows nitrogen deficiency. Avoid over-application of N as this reduces concentration of maturity, and causes excess plant growth.

APPLICATION — Fertilizer may be broadcast before seeding and worked in or banded 5 cm below and 5 cm to the side of the seed. High rates of banded potassium can reduce yield; therefore banded potassium should not exceed 60 kg K_2O/ha.

MICRONUTRIENTS — MANGANESE deficiency may be a problem on beans on some soils with pH values above 6.5. Correct the deficiency as soon as detected by spraying the foliage with 1.0 kg manganese/ha from manganese sulfate, or from manganese in chelated form, in 300 L of water. Use a "spreader sticker" in the spray. If the deficiency is severe a second spray may be beneficial. Soil application is not recommended for manganese because of the large amounts required.

BORON — Beans are very sensitive to boron toxicity and should not be grown the year after boron has been applied for other crops.

ZINC deficiency has been reported on beans in Michigan, but appears to be very rare in Ontario.

DISEASE CONTROL

1. Plant seed that is free from organisms causing **bacterial blight, anthracnose, common mosaic** and **yellow mosaic.** The best source of snap bean seed free from anthracnose and blight is western United States.
2. Practise crop rotation of at least 3 years to help control Fusarium and other soil-borne root rots, bacterial blight, anthracnose, and Sclerotinia white mold. Where disease is a problem it may be necessary to practise a 4- to 5-year rotation. Include in the rotation crops **other than** field beans, snap beans, pole beans, kidney beans, lima beans, soybeans and peas.
3. Maintain vigorous plant growth. Fertilize adequately. Avoid poorly-drained or compacted soils.
4. Do not cultivate or harvest when plants are wet.
5. **Plow** under crop residues in the fall to hasten destruction of disease organisms. Do not spread bean refuse or manure containing bean refuse on land intended for beans during the next 3 years.

COMMON MOSAIC AND YELLOW MOSAIC — Common mosaic virus is seed-borne and is also spread by aphids from infected beans. Some of the recommended snap beans are resistant to this virus. Check with your seed supplier. Avoid planting beans next to forage legumes or sweet clover from which aphids may spread yellow mosaic.

SCLEROTINIA WHITE MOLD — Plant fields in exposed areas where air circulation is maximum. For snap beans grown in fields where white mold has been a problem in recent years, spray at first bloom with one of:

1. benomyl
   (i) Benlate 50 WP 2.25 kg (14 days)
2. dichloran
   (i) Botran 75 W 3.25 kg (2 days)
3. iprodione
   (i) Rovral WP 1.5 kg (15 days)
   (spray at 50% bloom)

Spray must penetrate the crop canopy and contact blossom petals. Use of drop nozzles and overhead nozzles, and high pressure (up to 200 kPa) give best results. Applications made after bloom are not effective. If wet weather persists, a second spray will be beneficial.

BEANS (SNAP AND LIMA) (Continued)

BRONZING — Bronzing is a physiological disorder caused by high levels of atmospheric ozone associated with air pollution. It occurs following the initiation of flowering and after the older leaves become fully mature. A bronze-colored stipple develops on the pods and the upper surface of the leaves. Pod and seed set are usually reduced and the plants age prematurely. Dry beans and limas appear more sensitive than snap beans, and cultivars within these types differ in susceptibility.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. **(See Chemical Seed Treatment, page 30).**

LEAFHOPPERS, MEXICAN BEAN BEETLE AND GREEN CLOVERWORM — Spray with one of:

1. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 L (5 days)
2. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (3 days)
   (ii) [2]Guthion 50 W 1.1 kg (3 days)
   (iii) [2]APM 50 WP 1.1 kg (3 days)
   (iv) [2]Guthion Solupak 50 WP 1.1 kg (3 days)
3. endosulfan
   (i) Thiodan 4 EC 2.1 L (2 days)
   (ii) Endosulfan 400 1.4-2.5 L (2 days)
   (iii) Endosulfan 50 WP 1.1 kg (2 days)
   (iv) Thionex 50 W 1.1-1.5 kg (2 days)
4. dimethoate
   (i) Cygon 480-E 0.75 L (7 days)
   (ii) Cygon 4E 0.85-1.25 L (7 days)
5. malathion
   (i) Malathion 25% WP 4.5 kg (3 days)
   (ii) Malathion 500 EC 2.75 L (3 days)

Note: 4 and 5 are not effective on green cloverworm.

CORN BORER — Corn borer has been a problem on snap beans in some areas in the past few years. Control requires a number of repeated applications of insecticides timed carefully. Consult your processor and Crop Advisor or Pest Management Advisor. The following insecticides are registered for control:

1. permethrin
   (i) Ambush 500 EC 200 mL (7 days)
2. [1]methomyl
   (i) [1]Lannate 2.25 L (7 days)
3. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (3 days)
4. carbaryl
   (i) Sevin XLR Plus 5.25 L (5 days)

APHIDS — Spray with one of:

1. dimethoate
   (i) Cygon 480-E 0.75 L (7 days) **(lima beans only)**
2. malathion
   (i) Malathion 25 WP 3.25-4.5 kg (3 days) **(lima beans only)**
   (ii) Malathion 500 EC 2.75 L (3 days) **(lima beans only)**
3. naled
   (i) Dibrom 8E 1.1 (4 days) **(lima beans only)**
4. azinphos-methyl
   (i) Guthion Solupak 50 WP 1.1 kg (3 days) **(green beans only)**
   (ii) Guthion 240 SC 2.25 L (3 days) **(green beans only)**

TARNISHED PLANT BUG — Effectively controlled with dimethoate when sprayed for aphids or leafhoppers.

[1]*Minimum period before reentry is 24 hours.*
[2]*Minimum period before reentry is 48 hours.*

Do Not Feed Bean Refuse to Livestock or Poultry if the crop was Treated with endosulfan, dimethoate or benomyl.

BEET

CULTIVARS
(Revised for 1992)

MINERAL SOIL	MUCK SOIL
Gladiator	Avenger (2)
King Red	Big Red (1,2)
Ruby Queen	Detroit Rubidus (1)
	Pacemaker III (1,2)
BUNCHING	Red Ace (1)
Avenger	Ruby Queen (1)
Crosby Egyptian	Supra (1,2)
Detroit Dark Red	
Greentop	
Little Egypt	
Sangria	

PROCESSING
As recommended by processors

(1) Suitable for fresh market
(2) Suitable for processing

SEED TREATMENT

Treat seed before planting with thiram seed protectant. Follow manufacturer's directions.

TRANSPLANTING

For very early beets, sow seed in the greenhouse six to seven weeks before transplanting to the field in mid-April. In the field, space the plants 8 cm apart in rows 30 to 40 cm apart.

FIELD SEEDING AND SPACING

For a continuous supply of beets for bunching, sow seed at two-week intervals, from early April to the end of July. For storage and processing, sow about 10 weeks before late-fall harvesting. Seed will not germinate at temperatures lower than 4°C. Optimum germination temperature is from 10 to 29°C. Sow seed 12 to 20 mm deep. About 7 kg of seed will plant one hectare.

Thin plants 5 to 8 cm apart. No thinning is required on muck soils when seeders are adjusted to ensure a stand of 32 to 40 plants per metre of row. Rows 30 to 40 cm apart, depending on foliage size of cultivar.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply up to 40 kg N/ha. If manure is applied or legume sod is **plowed** down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — On MINERAL SOILS broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be sidedressed.

MICRONUTRIENTS — BORON deficiency shows up as a breakdown and corky, dark discoloration of internal tissues. **(See page 25).**

MANGANESE — Deficient plants show marked yellowing between the leaf veins; the veins themselves remain green. To correct a deficiency spray with manganese sulfate **(see page 25).**

DISEASE CONTROL

DAMPING-OFF AND SEEDLING DISEASES — **(See Seed Treatment, page 30).**

NEMATODES — To avoid damage from sugar-beet cyst nematode, do not plant beets following rhubarb, spinach or beets. **(See Crop Rotation and Nematodes, pages 31 and 32).**

INTERNAL BREAKDOWN (BORON DEFICIENCY) — Most likely to occur on alkaline soils after prolonged hot, dry periods. **(See Boron, page 25).**

INSECT CONTROL

LEAF MINER — Usually required only for bunching beets. When mines first appear spray with one of:

1. dimethoate
   (i) Cygon 480-EC 0.7 L (3 days)
2. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 E 350 mL (15 days)
3. malathion
   (i) Malathion 25 WP 4.5 kg (7 days)
   (ii) Malathion 500 EC 1.75 L (7 days)

APHIDS — If a problem, spray with one of:

1. dimethoate
   (i) Cygon 480-EC 0.75 L (3 days)
2. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 E 350 mL (15 days)
3. diazinon
   (i) Diazinon 50 WP 1.1 kg (14 days)
   (ii) Diazinon 500 EC 1.1 L (14 days)
   (iii) Basudin 500 EC 1.1 L (14 days)

[3]*Minimum period before re-entry is 7 days.*

QUALITY AND STORAGE

Heavy rains following a hot, dry period, or extended periods of high temperature will cause poor **colour.** Rains in the late summer or early fall, when cooler temperatures occur, may increase the intensity of **colour.** In general, cool temperatures produce the best flesh **colour.**

Mature topped beets may be stored for up to 5 to 6 months at 0°C and 90 to 95% relative humidity.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS

COLE-CROP CULTIVARS (Revised for 1992)

CABBAGE

Early
Early Greenball[1]
Early Marvel[1]
Tucana[1]
Luna (Polar Green)
Green Express YR
Headstart
Sun-up
Charmant

Mid-season
Green Express YR
Shamrock
Superette
Sanibel YR
Market Prize
Prime Time
Survivor (Questo)

Late (storage type)
Hinova
Multiton
Safekeeper II
Strukton
Bartolo
Bislet (trial)
Zerlina

Savoy
Savoy King
Chieftain
Ice Prince
Ice Queen

Red
Ruby Ball
Red Acre YT
Ruby Perfection

CAULIFLOWER[3] — Listed in approximate order of maturity.

Early Crop
Snow Crown
Polar Express

Mid-season
Majestic (trial)
Andes
Rushmore (trial)
Fremont (trial)

Late Crop
Snow Crown
White Sails
Rushmore (trial)
Andes
Fremont (trial)
White Rock

BROCCOLI — Listed in approximate order of maturity.

Paragon
Symphony
Cruiser
Premium Crop
Leprechaun (trial)

BRUSSELS SPROUTS

Jade E
Lunet[4]
Silverstar YT[4]
Valiant[4] (trial)

[1]*For early areas only.*
[2]*Not recommended for long-term storage.*
[3]*Cauliflowers listed are for fresh market, to produce curds not more than 20 cm in diameter. For processing cultivars, growers should follow processors' requirements.*
[4]*Probably matures too late for zones other than A, B, and C.* **(See Figure 1, page 13).**
YT: Fusarium Yellows tolerant**
YR: Fusarium Yellows resistant**
***Based on seed company claims and Field Trial Testing.*

Consult OMAF Factsheet, *Production and Handling of Broccoli,* Agdex 252/20.

SEED TREATMENT

Sow seeds that have been hot-water-treated and dusted with thiram or captan seed protectant. Follow manufacturer's directions. Hot-water treatment **(see page 30)** is most important to help prevent black rot, blackleg and bacterial leaf spot.

To control black rot, seed may be treated with streptomycin as an alternative to hot-water treatment. Follow manufacturer's directions on the label.

SEEDING AND SPACING

About 300 to 350 grams of seed will provide enough transplants for 1 hectare at standard spacing.

CABBAGE (EARLY), BROCCOLI — Rows 60 to 75 cm apart. Plants 30 to 45 cm apart.

CABBAGE (LATE), CAULIFLOWER, AND BRUSSELS SPROUTS — Rows 75 to 90 cm apart. Plants 45 to 60 cm apart.

The newer compact hybrids may be grown at closer spacings than the older traditional cultivars.

With Brussels sprouts grown for a once-over harvesting and especially where smaller sprouts are required for freezing, uniformity of the sprouts up the stem can be improved by growing the plants on a closer square spacing, e.g. 60 x 60 cm, or even as close as 53 x 53 cm.

For broccoli crops anticipated to be harvested during the hot humid weather or late August to early September, plant spacings should be increased to the wider end of the range recommended.

DIRECT FIELD SEEDING

Direct seeding in the field is practical for late summer and fall crops of cabbage, cauliflower, broccoli and Brussels sprouts. If precision seeders are used, it is false economy not to use graded seed. Some seeder units may be operated with seeds of well-defined sizes to give precise spacings on the ground. Extra care must be taken with soil preparation, and it may be necessary to irrigate before seeding to ensure good moisture conditions for germination. Depth of seeding should be 6 to 12 mm.

Direct seeding is particularly applicable where high plant populations are required. Seeding date should be 10 to 14 days after the normal date for seeding for a transplant crop of the same season of maturity. Even for the most favorable areas of Ontario, crops should probably not be direct seeded after about June 30.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS, broccoli, cauliflower and Brussels sprouts should receive 130 kg N/ha; and cabbage 170 kg N/ha. For MUCK SOILS suggested maximum is

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

130 kg N/ha with 70 kg/ha preplant plus two sidedresses of 30 kg/ha each, while cabbage should receive an initial 100 kg/ha preplant. If manure is applied or legume sod is plowed down, reduce the N application. **(See tables on pages 17 and 19).**

APPLICATION — Broadcast three-quarters of the N and all of the phosphate and potash required before planting, and work in. The remainder of the N should be side-dressed about three weeks after field setting. If rainfall is excessive, an additional 40 kg N/ha may be side-dressed on sandy soils. For MUCK SOILS, up to 70 kg N/ha should be applied before planting and the rest split into two equal side-dressings as needed.

STARTER SOLUTION — If no insecticide is being added to the planting water, use a starter solution high in N such as 20-20-20 at 1 kg/200 L and apply 0.2 to 0.3 L per plant. Under high-temperature conditions or in dry sandy soils use only 1/2 kg of 20-20-20/200 L of water. This will reduce the risk of crop injury under these growing conditions.

MICRONUTRIENTS — BROWN HEART or HOLLOW STEM (BORON DEFICIENCY) — On soils known to be deficient in boron, apply 2.5 to 3.0 kg of boron/ha and disk-in before planting. Foliar sprays of boron can be made during the growing season (see page 25). Boron deficiency has been shown to cause Hollow Stem in broccoli, but all Hollow Stem is not caused by boron deficiency.

WHIPTAIL (MOLYBDENUM DEFICIENCY) — This deficiency causes whiptail in cauliflower, broccoli, and Brussels sprouts. If molybdenum is deficient, apply sodium molybdate mixed with the fertilizer at rates supplying 0.6 to 0.8 kg of molybdenum/ha or apply 10 to 15 g of molybdenum per 100 L of water at 0.3 L per plant at transplanting. If deficiency symptoms appear in the field, spray immediately with 60 g of molybdenum dissolved in 300 L of water applied to one hectare.

SPECIAL PROBLEMS

CABBAGE SPLITTING

When the heads are well developed, they may split or burst if rain or a heavy irrigation follows a dry spell. Splitting results from rapid new growth due to the increased moisture. Splitting may be partially avoided by checking the plants' growth, e.g. by deep cultivation to break some of the roots. Proper irrigation may prevent splitting by helping to maintain steady plant growth.

CABBAGE BOLTING

Premature seedstalk development may occur when plants are started too early and grown at too low temperatures early in the growing season. The earlier the seed is sown, the greater the bolting tendency. Bolting may also be caused by extreme changes in temperature, poor soil conditions, low nutrient levels, or other factors which cause checks to plant growth. Some cultivars, particularly early ones, are more susceptible to bolting than others.

CAULIFLOWER BUTTONING

Buttoning is the premature formation of a cauliflower curd, and because the curd forms very early in the plant's life, the leaves are not large enough to nourish the curd to a marketable size. Buttoning usually occurs shortly after planting in the field, when normal plants of the same age are growing vegetatively. Losses are usually most severe in the early-planted crop during cold, wet seasons, when vegetative growth is checked. Conditions which may cause buttoning include:

- a too-rapid hardening-off treatment of young plants raised under protection
- insufficient hardening-off treatment of young plants before being planted in the field
- unbalanced soil fertility in the field (particularly low nitrogen)
- low soil moisture
- extreme and continued cold weather (e.g. 4 to 10°C for 10 days or more) especially in combination with excess moisture
- certain diseases, insects and trace-element deficiency, such as club root, root maggot and molybdenum deficiency (whiptail)

In short, conditions which reduce the vigour of the plant and retard vegetative growth appear to encourage buttoning. Some cultivars, particularly early ones, are more susceptible than others.

CAULIFLOWER BLANCHING

A perfect head of cauliflower is essentially pure white or pale cream. Heads exposed to sunlight develop an objectionable yellow pigment. While the head is small it is covered by the small inner leaves which curve over it, but as the head grows and enlarges, these leaves begin to lift, and some other means of covering is necessary to exclude sunlight. The usual method is to tie the outer leaves over the heads when the heads are 8 to 10 cm in diameter.

The heads tied at different times should be marked by different **colours** of twine or rubber bands to indicate probable maturity date and thus facilitate harvesting. In hot weather, blanching may take only 3 to 4 days, but in cool weather, when growth is slow, 8 to 12 days or more may be required.

Some cultivars are better able than others to give natural curd protection by the inner wrapper leaves, without tieing. Generally speaking, cultivars originating in Europe, and which appear in the recommended list in this publication, have better natural curd protection than the traditional North American cultivars.

BROCCOLI HARVESTING

The heads are cut with 15 to 20 cm of stem. Lateral shoots from the axils of the leaves develop into marketable heads soon after the terminal head is removed. These laterals produce a continuous crop for several weeks. However, some of the new hybrids produce very few laterals. Continuity of production with these cultivars may be obtained by successive plantings in the spring and summer. Heads should be cut when the clusters are green and compact. Open and yellow clusters are undesirable.

BRUSSELS SPROUTS HARVESTING

Harvesting should begin when the sprouts are firm and well formed. In picking, the leaf below the sprout is broken off and the sprout is removed. The upper sprouts continue to form and enlarge as the lower ones are harvested. In an early crop, the lower sprouts should be picked as soon as they mature; otherwise, they will open out, go soft and yellow, then rot.

For a once-over harvest, the plants should be topped, i.e., the growing point should be removed to prevent any further extension of growth and to encourage the maturity of the small sprouts at the top of the stem. Topping is normally done when the sprouts at the

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

bottom of the stem are about 12 to 20 mm in diameter. In this way, a full stem of uniform marketable-sized sprouts will develop about 4 weeks later. Deleafing is necessary before a once-over harvest, but it should not precede harvesting by more than a day; otherwise, yield will be adversely affected.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF, WIRESTEM, BLACK ROT*, BLACKLEG, SOFT ROT, BACTERIAL LEAF SPOT OF CAULIFLOWER — Sow seed that has been hot-water treated and dusted with thiram or captan. Hot-water treatment **(see page 30)** is most important to help prevent black rot, blackleg, and bacterial leaf spot. For the control of black rot, as an alternative to hot-water treatment, treat the seed with streptomycin. Caution: streptomycin may be toxic to some cultivars. Follow manufacturers' directions.

Field seedbeds should not be located downhill from where cabbage and related crops have been grown, and where residues of these crops will be blown by wind or spilled from passing trucks, etc. To control disease-causing fungi and nematodes in seedbed soil, steam the soil or fumigate it with Vapam or Vorlex according to manufacturer's directions.

In the field, follow, where possible, a 3-year rotation with unrelated crops whether the crop is transplanted or direct seeded.

Avoid working among plants when they are wet. Do not irrigate with overhead sprinklers. In the fall or early spring, break up the crop refuse thoroughly and incorporate it into the soil.

*BLACK ROT — Some cultivars are more susceptible to this disease than others. Check the seed packet to be sure that the incidence of black rot is not greater than 1 in 30,000.

YELLOWS — Use resistant cultivars (consult seed catalogue). If susceptible cultivars are grown, produce transplants in steamed or fumigated soil, and transplant to fields where yellows has not previously appeared.

CLUBROOT — This fungus causes swollen roots **(consult OMAF Factsheet, *Diseases of Cruciferous Crops*, Agdex 252/635).** The resting spores in the fungus persist in soil at least 7 years. The organism is carried within and between fields in moving water. Therefore, avoid wet, poorly drained soils. Grow seedlings or transplants in soil free of disease. Beds may be fumigated with Vorlex or Vapam (consult manufacturer's label for directions). The most reliable control measure is liming with finely ground lime to a pH of 7.2 **(consult OMAF Factsheet, *Soil Acidity and Liming*, Agdex 534).** Calcitic lime is preferable to dolomitic lime to attain a high level of soluble calcium (unless soils are low in magnesium). Where soil pH is above 7.0, Gypsum is a more soluble source of calcium.

Do not use hydrated lime on seedbeds. Fumigate seedbeds with Vorlex or Vapam if disease-free beds are not available (consult manufacturer's label directions).

Where Agral 90 is to be used for the control of clubroot, use 500 mL of product in 100 L of transplant water and apply this solution at a rate of 200 mL per plant. Do not tank-mix this solution.

Some field control is possible by using quintozene (PCNB 75) in the transplant water at the rate of 1.5 kg in 200 L, applying at least 0.2 L per plant. This will be 3650 to 5600 L/ha. Provide good agitation. Do not use quintozene emulsion. No other method of applying quintozene is recommended.

DOWNY MILDEW — May appear in the seedbed or late in season. Downy mildew spreads rapidly in cool, wet weather. Under these conditions preventive spraying is recommended, as the following fungicides will only prevent new infections and not eradicate established lesions.

1. zineb
   (i) Zineb 80 WP 2.25-3.25 kg (7 days)
2. tri-basic copper sulphate*
   (i) Copper 50 W 4.5 kg
   **fixed copper may be phytotoxic to cauliflower*
3. chlorothalanil
   (i) Bravo 500 2.5-4.8 L (7 days)

BLACK LEAF SPOT (Alternaria) — May be damaging in warm, wet seasons. Spray with one of the materials listed for downy mildew. Maneb 80 WP 2.25 to 3.25 kg (14 days) may be used only on cabbage.

Note: It is important to control downy mildew and black leaf spot on cabbage intended for prolonged storage (more than 3 months). Spray with maneb or chlorothalanil 2 or 3 times during the latter part of the season.

NEMATODES — **See page 32.**

INSECT CONTROL

ROOT MAGGOTS

Planting-water treatment

Use one of:

1. azinphos-methyl, Guthion 50 WP or APM 50 W or Guthion Solupak 50 WP, 1 kg in 1000 L of water. Apply 200 mL per plant in transplant water. Repeat in 2 to 3 weeks.
2. chlorpyrifos, Lorsban 50 W 325 g/1000 L of water. (32 days) **(For cabbage only)** Do not use starter fertilizers or lindane with Lorsban 50 W.

Treatment after Planting

Use one of:

1. [2]azinphos-methyl, [2]Guthion 50 WP or [2]APM 50 W or [2]Guthion Solupak 50 WP, 1 kg in 1000 L of water. Apply 200 mL per plant. Repeat in 2 to 3 weeks.
2. chlorpyrifos, Lorsban 4E 210 mL/130 L of water/1000 metres of row (at least 1000 L of water/ha). Apply in a 10-cm band on each side of the plant 3 days after transplanting. Note: this product has a 32 days-to-harvest interval.

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

Caution

— Do not use emulsifiable formulations in the planting water.
— Do not add fertilizer to planting water containing an insecticide unless recommended by the manufacturer or until experience has proven the mixture to be safe.

Direct-seeded crops

Use:

1. chlorpyrifos, Lorsban 4E 210 mL/130 L of water/1000 metres of row (at least 1000 L of water/ha). Apply 10 cm on each side of the plant 7-10 days after seeding. Note: this product has a 32 days-to-harvest interval.

FLEA BEETLE — Spray with one of:

1. endosulfan
   (i) Thiodan 4 EC 2.0 L (7 days)
   (ii) Endosulfan 400 EC 1.5-2.0 L (7 days)
2. carbaryl
   (i) Sevin XLR Plus 1.25-2.25 L (3 days for cabbage and cauliflower, 5 days for broccoli and sprouts)
3. cypermethrin
   (i) Ripcord 400 EC 90-125 mL (3 days)
4. deltamethrin
   (i) Decis 2.5 EC 300-400 mL (3 days — use on cabbage only)

CABBAGEWORM, CABBAGE LOOPER, DIAMONDBACK MOTH CATERPILLAR — Infestations of cabbageworm and diamondback moth caterpillar may begin early in the season, whereas cabbage loopers usually appear after mid-July. Because the recommended insecticides are less effective against large larvae, check carefully for young larvae, beginning soon after planting. Begin application of insecticides when young larvae are found and continue at 5- to 10-day intervals, or as necessary for adequate protection of the crop.

To limit the development of resistance, **insecticides from one of the following groups must be used alternately with one from another group.** Use insecticides in Group B during the fall as they are more effective than the others under cool conditions.

Group A

1. *Bacillus thuringiensis*
   (i) Dipel WP 0.75-1.1 kg
   (ii) Thuricide HPC 2.25-4.25 L

Use higher rates for looper control, heavy infestation or when foliage is dense (0 days).

Group B (Synthetic Pyrethroids)

1. permethrin
   (i) Ambush 500 EC 70-140 mL (3 days cabbage, cauliflower, Brussels sprouts; 7 days broccoli)
   (ii) Pounce 384 EC 90-175 mL (3 days cabbage, cauliflower, Brussels sprouts; 7 days broccoli)
2. fenvalerate
   (i) Belmark 300 EC 150-325 mL (14 days cabbage, cauliflower, Brussels sprouts; do not use on broccoli)
3. deltamethrin
   (i) Decis 2.5 EC 300-400 mL (3 days)
4. cypermethrin
   (i) Ripcord 400 EC 90-125 mL (3 days)

Group C (Carbamates)

1. [1]methomyl
   (i) [1]Lannate L 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)

Group D (Chlorinated Hydrocarbons)

1. endosulfan
   (i) Thiodan 4 EC 2.0 L (7 days)
   (ii) Endosulfan 400 EC 1.5-2.0 L (7 days)

Group E (Organo-phosphates)

1. naled
   (i) Dibrom 8E 1.1 L (4 days)
2. [2]methamidophos
   (i) [2]Monitor 480 LC 1.1-2.25 L (7 days cabbage, cauliflower; 14 days broccoli, Brussels sprouts)
3. azinphos-methyl
   (i) [2]Guthion Solupak 50 WP 1.1-1.75 kg (7 days Brussels sprouts, 15 days broccoli and cauliflower, 21 days cabbage)
   (ii) [2]Guthion 240 SC 2.25-3.5 L (7 days Brussels sprouts, 15 days broccoli and cauliflower, 21 days cabbage)

APHIDS — Good coverage (bottom of leaves) is essential for aphid control. Spray with one of:

1. dimethoate
   (i) Cygon 480 E 0.75-1.0 L (4 days cabbage, cauliflower, broccoli; 21 days Brussels sprouts)
   (ii) Dimethoate 40 EC 0.85-1.25 L (4 days cabbage, cauliflower, broccoli; 21 days Brussels sprouts)
2. [2]oxydemethon-methyl
   (i) [2]Metasystox-R 240 SC 1.75-2.25 L (24 days cabbage, cauliflower, Brussels sprouts; 21 days broccoli). Use only once per season on broccoli.
3. [1]methomyl
   (i) [1]Lannate L 2.25 L (1 day cabbage; 7 days cauliflower, broccoli, Brussels sprouts)
4. [2]methamidophos
   (i) [2]Monitor 480 LC 1.1-2.25 L (7 days cabbage, cauliflower; 14 days broccoli, Brussels sprouts)
5. naled
   (i) Dibrom 8E 1.1 L (4 days)
6. azinphos-methyl
   (i) Guthion Solupak 50 WP 1.1-1.75 kg (7 days Brussels sprouts, 15 days broccoli and cauliflower, 21 days cabbage)
   (ii) Guthion 240 SC 2.25-3.5 L (7 days Brussels sprouts, 15 days broccoli and cauliflower, 21 days cabbage)

THRIPS — Dimethoate, as recommended for aphids, and all materials listed in Group B as recommended for cabbageworm, etc. will give some control of thrips. Insecticides from Group B must be used alternately with dimethoate to limit development of resistance.

(Continued on page 43)

PESTICIDE NAMES

Refer to this section for a cross-reference of brand names and common names of pesticides recommended in this publication. The centerfold section may be removed, if desired, for easier reference.

PESTICIDE NAMES

b - bactericide
i - insecticide
f - fungicide
m - miticide
n - nematicide
h - herbicide
g - growth regulator
() Schedule (see list below)

Common Names		Brand Names	Common Names		Brand Names
anilizene	(3) f	Dyrene	iprodione	(3) f	Rovral
azinphos-methyl	(2,5) i	Guthion, Guthion Solupak APM, Azinphos-Methyl	lindane	(2) i	Lindane
			maleic hydrazide	(3) g	Royal MH 60 SG
Bacillus thuringiensis	(3) i	Thuricide, Dipel Bactospeine-A	malathion	(3) im	Malathion
			mancozeb	(3) f	Dithane M-45, Manate 200
benomyl	(3) f	Benlate	maneb	(3) f	Dithane M-22, Manzate D, Maneb
captan	(2) f	Orthocide, Captan			
carbaryl	(3) i	sevin	metalaxyl	(2) f	Ridomil, Subdue
carbathiin + thiram	(3) f	Pro-Gro	metam-sodium	(3) bifnh	Vapam
carbofuran	(2,5) i	Furadan	methamidaphos	(5) i	Monitor
chlorfenvinfos	(2,5) i	Birlane	methidathion	(2) i	Supracide
chlorothalanil		Bravo	methomyl	(2,5) i	Lannate
chlorpyrifos	(2,3) i	Lorsban	methoxychlor	(3) i	Marlate, Moxy, Methoxychlor
cypermethrin	(2) i	Cymbush, Ripcord	methyl bromide	(1) ifnh	MB- C2, Brom-o-gas
dazomet	(2) ifnh	Basamid	metiram	(3) f	Polyram
deltamethrin	(2) i	Decis	methyl isothiocyanate/ 1,3 dichloropropene	(2) bifnh	Vorlex Plus
diazinon	(2,3) i	Basudin, Diazol	naled	(2) i	Dibrom, Bromex
1,3-dichloropropene	(2) ifn	Telone II	oxamyl	(5) i	Vydate
1,3-dichloropropene/methyl isothyiocyanate mixture	(2) bifnh	Vorlex Plus	oxine benzoate	(3) f	No-Damp
			oxydemeton-methyl	(2) im	Metasystox-R
1,3-dichloropropene + chloropicrin	(2) ifn	Telone C-17	parathion	(5) im	Parathion
dichloran	(3) f	Botran	permethrin	(3) i	Ambush, Pounce
dicofol	(2) m	Kelthane	phorate	(2,5) i	Thimet, Cygard
dimethoate	(2,3) im	Cygon, Dimethoate 40, System	phosmet	(3) i	Imidan
			piperonyl butoxide	i	piperonyl butoxide
diquat	(3) h	Reglone	pirimicarb	(2) i	Pirimor
disulfoton	(5) im	Di-Syston	quintozene (PCNB)	(3) f	Quintozene, Terrachlor
endosulfan	(2) i	Thiodan, Endosulfan, Thionex	rotenone	(3,6) i	Rotenone
fenvalerate	(2) i	Belmark	streptomycin	(3)	Agri-Mycin 17
ferbam	(3) f	Ferbam	sulphur	(6) f	Micro-Niasul
fixed copper	(2,3) bf	kocide, etc.	thiophanate-methyl	(3,6) f	Easout
fonofos	(2,5) i	Dyfonate	thiram	(3) f	Thiram
formaldehyde	(3) i	Formalin	zineb	(3) f	Thiogreen, Zineb

The number within the brackets( ) identify the Schedules in which the BRAND NAME products listed in this Section are classified under the Pesticides Act.

Explanation of Schedules:

Schedule 1 Restricted. Use permit only.

Schedule 2 Restricted to agriculturists, licenced exterminators and registered custom sprayers.

Schedule 3 May be available for "Domestic" purposes if so registered.

Schedule 5 Limited to application by an agriculturalist.

Schedule 6 Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you. (See page 5).

PESTICIDE NAMES (Continued)

b - bactericide
i - insecticide
f - fungicide
m - miticide
n - nematicide
h - herbicide
g - growth regulator
() Schedule (see list below)

Brand Names		Common Names
Ambush, Pounce	(3) i	permethrin
APM, Azinphos-Methyl Guthion, Guthion Solupak	(2,5) i	azinphos-methyl
Bactospeine-A, Dipel, Thuricide	(3) i	Bacillus thuringiensis
Basamid	(2) ifnh	dazomet
Basudin, Diazol	(2,3) i	diazinon
Belmark	(2) i	fenvalerate
Benlate, Benomyl	(3) f	benomyl
Benomyl, Benlate	(3) f	benomyl
Birlane	(2,5) i	chlorfenvinfos
Botran	(3) f	dichloran
Bravo	(3) f	chlorothalanil
Bromex, Dibrom	(2) i	naled
Captan, Orthocide	(2) f	captan
Cygon, Sys-tem, Dimethoate-40	(2,3) im	dimethoate
Cymbush	(2) i	cypermethrin
Decis	(2) i	deltamethrin
Diazol, Basudin	(2,3) i	diazinon
Dipel, Thuricide, Bactospeine-A	(3) i	Bacillus thuringiensis
Dibrom, Bromex	(2) i	naled
Dimethoate-40, Cygon, System	(2,3) im	dimethoate
Di-Syston	(5) im	disulfoton
Dithane M-22, Maneb Manzate D	(3) f	maneb
Dithane M-45, Manzate 200	(3) f	mancozeb
Dyfonate	(5,2) i	fonofos
Dyrene	(3) f	anilazine
Easout	(3,6) f	thiophanate-methyl
Endosulfan, Thiodan, Thionex	(2) i	endosulfan
Ethion	(2) i	ethion
Ferbam	(3) f	ferbam
Formalin		formaldehyde
Furadan	(5,2) i	carbofuran
Guthion, Guthion Solupak APM, Azinphos-Methyl	(5,2) i	azinphos-methyl
Imidan	(3) i	phosmet
Kelthane	(2) m	dicofol
Kocide	(3) bf	fixed copper
Lannate L	(5,2) i	methomyl
Lindane	(2) i	lindane
Lorsban	(2,3) i	chlorpyrifos
Malathion	(3) im	malathion
Maneb, Dithane M22, Manzate D	(3) f	maneb
Manzate D, Maneb, Dithane M22	(3) f	maneb
Manzate 200, Dithane M45	(3) f	mancozeb
MB-C2	(1) ifnh	methyl bromide + 2% chloropicrin
Metasytox-R	(2) im	oxydemeton-methyl
Methoxychlor	(3) i	methoxychlor
Micro-Niasul	(6) f	sulphur
Monitor	(5) i	methamidaphos
No-Damp	(3) f	oxine benzoate
Orthocide, Captan	(2) f	captan
Parathion	(5) im	parathion
Pirimor	(2) i	pirimicarb
Polyram	(3) f	metiram
Pounce, Ambush	(3) i	permethrin
Pro-Gro	(3) f	carbathiin + thiram
Quintozene, Terrachlor	(3) f	quintozene (PCNB)
Reglone	(3) h	diquat
Ripcord	(2) i	cypermethrin
Ridomil	(2) f	metalaxyl
Rotenone	(3) i	rotenone
Rovral	(3) f	iprodione
Royal MH 60	(3) g	maleic hydrazide
Sevin	(3) i	carbaryl
Streptomycin 17	(3) b	streptomycin
Sys-tem, Cygon, Dimethoate 40	(2,3) im	dimethoate
Supracide	(2) i	methidathion
Telone II	(2) ifn	1,3 dichloropropene
Telone C-17	(2) n	1,3 dichloropropene + chloropicrin
Terrachlor, Quintozene	(3) f	quintozene (PCNB)
Thimet	(2,5) i	phorate
Thiodan, Thionex, Endosulfan	(2) i	endosulfan
Thiogreen	(3) f	zineb
Thionex, Thiodan, Endosulfan	(2) i	endosulfan
Thiram	(3) f	thiram
Thuricide, Dipel, Bactospeine-A	(3) i	Bacillus thuringiensis
Vapam	(3) bifnh	metam-sodium
Vorlex Plus	(2) bifnh	1,3-dichlorpropene/methyl isothiocyanate mixture
Vydate	(5) i	oxamyl
Zineb, Thiogreen	(3) f	zineb

CABBAGE, CAULIFLOWER, BROCCOLI, BRUSSELS SPROUTS (Continued)

Cabbage varieties vary in their susceptibility to thrips. Cabbage should be harvested at the proper maturity since overmature cabbage is a prime target for thrip activity.

Lannate L @ 3.25 L (30 days) can be used on Brussels sprouts only, and only by ground equipment.

Consult OMAF Factsheet, *Thrips On Onions And Cabbage*, Agdex 250/612.

TARNISHED PLANT BUG — Dimethoate, as recommended for aphids will help control tarnished plant bug in broccoli and cauliflower.

[1]*Minimum period before re-entry is 24 hours.*
[2]*Minimum period before re-entry is 48 hours.*

STORAGE

Late cabbage (Ballhead type) has a storage life of at least 3 to 4 months if held at 0°C with a relative humidity of 90% and good air circulation. Harvested heads should be trimmed at the base and dead or damaged leaves discarded. Avoid bruising during handling. Pallet bins are commonly used for holding cabbage in storage. Heads may also be stored in bulk but require very careful piling to a depth of not over 1.5 m together with ample aeration of the pile with forced air. Pallet bins should be stored outside and subjected to the sun and light to control fungi, which develop on the wood and stain the cabbage.

CARROT

CULTIVARS
(Revised for 1992)

Processing	Packaging and Bunching	Use*
Camden	Apache	1,2
Chantenay strains	Canada Super X	1,2
Danvers 126	Candy Pak	1,2
Dess-Dan	Caropak	1,2
Processor II *(trial)*	Cellobunch	1,2
Royal Danvers	Chancellor	1,2
Spartan Bonus	Dominator	1
Tahoe *(trial)*	Gold Pak 28 and 263	1
	Orlando Gold	1,2
	Pack-Mor	1,2
	Prospector	1,2
	Six-Pak and Six-Pak II	1,2
	Sunrise	1,2

**Use: 1-Packaging 2-Bunching*

Note: For cultivar susceptibility to rusty root (Pythium root dieback) and cavity spot, see Cultivar Descriptions.

The carrot is a cool-season vegetable which is best adapted to areas of long, cool growing periods, free from extremes of temperature and moisture. The optimum mean temperature is between 16 and 21°C. High temperatures at the beginning of the growing season are injurious to the young plants. Continuous high temperatures in the latter stages of plant development may reduce yield, retard growth, and produce a strong-flavored, coarse root. Temperatures below 16°C will retard plant growth. The carrot is not tolerant to drought and so requires steady and relatively large amounts of moisture for optimum growth. Good rainfall distribution or irrigation throughout the growing season is necessary to prevent a check in growth.

CULTIVAR DESCRIPTIONS

Note: Cultivars are evaluated mostly on organic soils.

Apache — Early maturing with vigorous tops, good colour and appearance, smooth roots.

Camden — Danvers type with very good uniform internal **colour**, high yield potential, smooth exterior.

Canada Super X — Long, uniform roots, good internal and external **colour**, small core.

Candy Pak — Long and slender, good yield, good quality and appearance.

Caropak — Medium length, high yielding, good external **colour.**

Cellobunch — Very high yield potential, medium long, susceptible to green shoulders.

Chancellor — Long, good yielding, fairly uniform and smooth, tolerant to rusty root, blight and cavity spot, good **colour**, short-term storage.

Chantenay strains — Medium length, broad shoulders tapering to blunt tips, strong tops.

Danvers 126 — More tapering and longer than most Chantenay types, fair to good internal **colour.**

Dess-Dan — Long Danvers type with very small core and very good internal and external **colour.**

Dominator — Long, good yield potential, partly Imperator type, suited for deep muck soils.

Gold Pak 28 and 263 — Imperator type with a narrow shoulder and relatively smooth skin, highly resistant to splitting, strong top, fair yields.

Orlando Gold — Long slender root, uniform shape and size, good exterior **colour.**

Pak-Mor — Early Imperator type, dark orange **colour**, strong tops, tolerant to early bolting.

Processor II — Danvers type, high yield potential, good size, very good **colour**, smooth exterior and medium-size core.

Prospector — Medium length uniform roots, potential for high yield.

Royal Danvers — High-yielding long Danvers type with good **colour.**

CARROT (Continued)

Six-Pak and Six-Pak II — Very long, very smooth and uniform, excellent **colour,** good yielding, good resistance to cavity spot and rusty root, tolerant to blight. Six-Pak II has excellent resistance to cavity spot.

Six Pence — Medium-early, Imperator type, medium-strong tops, good **colour.**

Spartan Bonus — Long Danvers type, very uniform, smooth, high yielding, outstanding internal **colour.** Susceptible to seeders.

Sunrise — Medium length, good yield, tolerant to leaf blight.

Tahoe — High-yielding Danvers type with very good internal **colour**, a small core and medium short tops. Susceptible to cavity spot.

SOIL

Deep, loose, fertile soils that have good water-holding capacity are necessary for the development of long, straight roots. Well-drained sandy loam, peat, or muck are ideal for carrot production.

SEEDING AND SPACING

TIME — As early as soil and weather conditions permit in the spring up to July 1. Late carrots may 'burn off' if they emerge during hot, dry weather.

RATE — Market: 2 to 4.5 kg/ha. Processing: 1 to 2 kg/ha.

DEPTH — 12 to 20 mm.

ROW SPACING — 55 to 85 cm depending on planting and harvesting machinery.

RAISED BEDS — Sowing carrots on raised beds (15-20 cm high) improves carrot quality. One system that has provided good results uses beds that are 85 cm wide at the bottom and 50 cm wide on top. Seed carrots in 3 or 4 rows on the center of the bed at a rate to achieve 120-140 carrots/m for packaging carrots and 26 carrots/m for processing carrots.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply up to 60 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — On MINERAL SOILS it is suggested to apply 2/3 of the nitrogen before planting and the balance side-dressed when plants are 10 cm tall. On MUCK SOILS broadcast up to 60 kg N/ha before planting. This is a maximum. Adjust the rate downward if tops have been too vigorous in previous years.

MICRONUTRIENTS — **BORON** deficiency can cause necrosis in the growing tip or internal breakdown in carrot roots. Boron is recommended on new muck soils. Boron is applied mixed with the fertilizer at 2.6 kg boron/ha. Various sources of boron are available.

— **COPPER** deficiency may occur on acid peat and muck soils. It results in poor orange **colour** development in the carrot roots. Apply 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

DISEASE CONTROL

SEED DECAY, DAMPING-OFF — Planting carrot seed treated with thiram has resulted in improved stands.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LEAF SPOTS, BLIGHT — Apply about 5 sprays, starting in late July, using one of:

1. maneb
   (i) Maneb 80 WP 3.25 kg (14 days)
   (ii) Dithane M22 3.25 kg (14 days)
2. mancozeb
   (i) Manzate 200 2.25 kg (14 days)
   (ii) Dithane M-45 2.25 kg (14 days)
   (iii) Dithane DG 2.25 kg (14 days)
3. zineb
   (i) Zineb 80 W 3.25 kg (14 days)
4. chlorothalanil
   (i) Bravo 500 2.4-3.2 L (1 day)

An alternative weather-timed spray program is available in the Bradford area. In this program, fungicide sprays are applied according to the following rules:

(1) No fungicide is applied until blight appears on 1 to 2% of the leaf area. This coincides roughly with the time when blight is first detectable.

(2) After this time, apply a recommended fungicide at 7- to 10-day intervals when weather is favourable for blight; extend the interval between sprays when the weather is unfavourable for blight. Lack of rainfall or cool nights (minimum temperature less than 15°C) are unfavourable for blight.

After the leaves have closed over the rows, spray at 7-10 day intervals.

For further information, **consult OMAF Factsheet, *Weather-Timed Sprays for Carrot Blight Control,* Agdex 258/635,** and consult your Pest Management Advisor regarding blight assessments and blight-favourable weather.

SCLEROTINIA MOLD (of carrots, lettuce, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Use wider row spacings to encourage good air movement. See section on Storage.

1. benomyl
   (i) Benlate 50 WP 0.25-1.1 kg (15 days) (maximum of 3 applications per season)

NEMATODES — **See page 32.**

RUSTY ROOT (Pythium Root Dieback) — Follow a 3-year rotation with unrelated crops, e.g. onions. Avoid known severely infested fields. Sow seed after the soil has warmed up in the spring. Use disease-resistant cultivars, e.g. Spartan hybrids (see Cultivar Descriptions). Avoid heavy plant stands; obtain uniformly-spaced plant populations with precision-seeding equipment.

VIOLET ROOT ROT — Since the fungus causing this disease persists for several years and affects primarily carrots, the best control is to rotate with other crops, e.g. onions or crucifers.

CARROT (Continued)

CAVITY SPOT — This disorder has been found on the main taproot of carrots grown in Ontario. Research has shown that cultivars differ in susceptibility. Select cultivars which are least susceptible. **(Consult the Annual Vegetable Cultivar Trials and Research Report published by the Muck Research Station).** Do not over-fertilize. Obtain a soil test prior to seeding.

INSECT CONTROL

LEAFHOPPERS — Leafhoppers cause the spread of aster yellows. Apply 3 sprays at 10-day intervals in July and early August or starting as soon as aster leafhoppers appear. Also control weeds in headlands, ditchbanks, roadsides, etc., and control leafhoppers on adjacent celery and lettuce.

Spray with one of:

1. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 L (1 day)
2. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 EC 375 mL (15 days)

Note: Rapid killing is obtained using parathion; slower but more lasting control is obtained with carbaryl.

CARROT WEEVIL

1. phosmet
   (i) Imidan 50 WP 2.25 kg (40 days)

Spray when carrots are in the 2nd-3rd true-leaf stage. Repeat once 10 to 14 days later. Do not apply more than two times per season or later than 40 days before harvest. Spraying with phosmet may also reduce the carrot fly population.

CARROT RUST FLY — This insect is mainly a problem in the Bradford area marshes and Crumlin marsh. Growers in other areas should consult their Pest Management Advisor before initiating a routine spray program.

The carrot fly is monitored throughout the growing season in the Bradford area. Consult your Pest Management Advisor for information on participating in the program or for up-to-date information on timing of sprays. The first generation of flies is normally present from late May until late June, the second generation from late July until September.

Spray when recommended with one of:

Group A

1) cypermethrin
   (i) Cymbush 250 EC 280 mL (35 days)

Group B

1) diazinon
   (i) Diazinon 50 WP 1.1 kg (10 days)
   (ii) Basudin 500 EC 1.1 L (10 days)
2) [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (15 days)
   (ii) [3]Parathion 960 EC 375 mL (15 days)

Note: When flies are abundant, these sprays may not prevent damage to carrots growing adjacent to sheltered areas.

Cultural practices

Carrots seeded after June 1st are rarely attacked by the first generation of the carrot rust fly. Carrots harvested by early September should escape most second generation damage. If possible, avoid growing carrots immediately adjacent to sheltered areas (e.g., the canal banks of the Holland Marsh).

STORAGE

Mature topped carrots can be stored for up to 4 to 5 months at 0°C and a relative humidity of 90 to 95%.

Storage rots occur from infections of the carrot through wounds. Proper sanitation of the storage and handling equipment is necessary to help reduce infections.

[3]*Minimum period before re-entry is 7 days.*

CELERY

CULTIVARS
(Revised for 1992)

Main crop (green)

Deacon	Tendercrisp
Florida 683[1]	Utah 52-70 strains
Ventura[2]	Bishop *(trial)*[2]
Starlet[3]	Matador *(trial)*[3]
Picador*(trial)*[3]	

[1]*Suitable for storage*
[2]*Tolerant to bolting; suitable for early crop*
[3]*Tolerant to fusarium yellows*

CULTIVAR DESCRIPTIONS

Note: Cultivars have been evaluated on muck soils.

Bishop — Tall plants with compact hearts and thick smooth ribs. This cultivar has longer petioles than traditional Tall Utah types. Some tolerance to fusarium yellows, tolerant to bolting.

Deacon — Petioles are longer with deeper cupping than Tall Utah 52-70 types. Medium green colour, some tolerance to fusarium species.

Florida 683 — Medium tall plants with medium dark green foliage, relatively long heavy petioles and a well-developed heart. Susceptible to early bolting, no tolerance to fusarium yellows.

Matador — Tall plants with smooth, long petioles, medium green, good tolerance to fusarium yellows.

CELERY (Continued)

Picador — Tall, very uniform, dark green with long petioles. Best suited for processing. Good tolerance to fusarium yellows.

Starlet — Large and somewhat spreading plants with long petioles, medium to light green foliage. Tolerant to fusarium yellows. Quality will deteriorate if plants get over-mature.

Tall Utah 52-70 strains — Tall plants with medium to dark green foliage. Suitable for fresh market and processing.

Ventura — Tall plants with long petioles, dark green colour, tolerant to bolting, suitable for early crop.

SEED TREATMENT

Buy hot-water-treated seed or sow three-year-old seed to avoid seed-borne blight fungi. Treat seed before sowing with a protectant such as thiram, following manufacturer's instructions.

GROWING TRANSPLANTS

Sow seed in the greenhouse 10 to 12 weeks before field planting. About 140 grams of seed provide enough plants for one hectare when the standard field spacing is used.

The use of plug transplants allows machine transplanting and reduces transplant shock. Sow one seed per cell. Even watering and fertilization is critical in plug-plant production.

Until the plants emerge, a temperature of 21 to 24°C is suitable. The 18 to 24°C is ample for steady growth. Night temperatures should not drop below 13°C to lessen the production of "seeders". Plants for the early crop should not be set in the field until the danger of a prolonged cool period or actual freezing is over. If the plants have become too tall and spindly before field setting they can be clipped back to a height of 12 to 15 cm. Clipped plants facilitate transplanting but well-grown, untrimmed plants are preferable because they receive less check in growth.

Plants for the late crop may be started in outdoor seedling beds if water is available for irrigation. The seed may be sown with a seed drill in rows 15 to 20 cm apart, at the rate of 80 to 110 seeds per metre of row so that the stand will not need thinning before transplanting to the field. Or, seed may be broadcast in a finely prepared bed outdoors at the rate of 15 grams per 10 m^2. However, the first method provides sturdier plants.

PREMATURE SEEDSTALK DEVELOPMENT

The development of flowering shoots, or "bolting to seed", instead of the normal growth, is mainly due to exposure of young plants to temperatures below 13°C for 10 days or more.

The amount of bolting increases as the time of exposure is lengthened. Growers producing plants, especially for the early crop, should maintain greenhouse temperatures of 16 to 21°C. The plants can be hardened, if so desired, by withholding water the last 7 to 10 days before setting in the field. Do not harden-off celery plants by lowering temperatures.

SPACING

The standard spacing is 15 cm apart in rows 50-55 cm apart.

SOIL

Muck soil is ideal for celery production because of its high moisture-holding capacity. Celery may be grown successfully on well-drained mineral soil such as a sand-loam, but irrigation may be necessary under upland conditions. Rotation with other crops is an important aid in the control of diseases and insects.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS apply 195 kg N/ha. On MUCK SOILS apply up to 160 kg N/ha with 80 kg/ha preplant and the remainder applied in 2 sidedressings of 40 kg/ha as required. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — Apply 2/3 of the nitrogen at planting time and the remainder sidedressed in 2 or 3 applications as required.

SECONDARY AND MICRONUTRIENTS

CALCIUM — deficiency results in a physiological disorder known as "black heart", in which the celery heart turns black while the outer leaves are unaffected.

Spray directly into the heart of the plant with 1.0-1.8 kg calcium/ha from calcium chloride or calcium nitrate in 1000 L water. If celery is under moisture stress, reapply once a week.

MAGNESIUM deficiency appears as chlorosis between the dark green veins of the older leaves. Some celery cultivars are inefficient in taking up magnesium from the soil. Apply a foliar spray of magnesium sulfate at rates supplying 1.0-2.0 kg magnesium/ha in 1000 L water every 10-14 days starting when the plants are about 1/3 grown.

BORON deficiency results in a physiological disease known as "cracked stem" or "cat scratches". Apply 1-3 kg boron/ha (2-6 kg/ha on muck soils) with the fertilizer, and a foliar spray of 0.1-0.3 kg boron in 1000 L water. Spray when the young plants are about 15 cm tall. A second spray application may be required.

DISEASE CONTROL

EARLY BLIGHT (Cercospora), LATE BLIGHT (Septoria) — Sterilize soil for growing seedlings in flats or frames. Rotate outdoor seedbeds. Use three-year-old or hot-water-treated seed. Start spraying or dusting when seedlings are about 5 cm high and repeat weekly throughout season. Spray with one of:

1. maneb
   (i) Maneb 80 WP 2.25 kg (14 days, wash and trim)
2. mancozeb
   (i) Dithane DG 2.25 kg (14 days, wash and trim)
   (ii) Dithane M-45 2.25 kg (14 days, wash and trim)
   (iii) Manzate 200 2.25 kg (14 days, wash and trim)
3. anilazine
   (i) Dyrene 50 WP 2.25-3.25 kg (1 day, wash and trim)
4. metiram
   (i) Polyram 80 DF 2.25 kg after transplanting (14 days)
5. zineb
   (i) Zineb 80 W 2.25-3.25 kg (14 days)
6. fixed copper
   (i) Copper 50 W 3.25-6.75 kg (1 day)
7. chlorothalanil
   (i) Bravo 500 1.6-2.4 L on a 3 to 5 day schedule or 2.4-4.0 L on a 8 to 10 day schedule (7 days)

CELERY (Continued)

ASTER YELLOWS — See Leafhoppers (Insect Control Section).

FUSARIUM YELLOWS — This fungus persists in soil for many years. Avoid introducing it by preventing the movement of infested plants or soil from other farms or areas where the disease occurs. The fungus may be introduced in or on transplants and attached soil, in infested soil carried by flood water, by wind from infested fields nearby, and by workers and their tools and implements. If the disease is present, start seedlings in soil-less media or fumigated soil and plant in fields where the disease has not occurred before. Sanitation is important in preventing spread of this disease. Avoid cultivation practices that can spread infested soil from one area to the rest of the field. Do not return celery trimmings to infested fields after harvest. Practice a 2- to 3-year rotation with onions or lettuce to reduce spore populations in infested fields. Avoid the use of carrots in the rotation scheme. Starlet, Matador, and Picador cultivars are resistant to the disease while Utah 52-70 HK and Deacon are tolerant to the disease when soil population levels of the fungus are moderate. Excessive heat and drought stress may diminish this tolerance. Other cultivars are susceptible to this disease. For more details, **consult OMAF Factsheet, *Fusarium Yellows of Celery*, Agdex 251/635.**

CUCUMBER MOSAIC VIRUS — Control weeds bordering the crop area. Weeds are the source from which aphids bring in the mosaic virus. Rogue out plants if mosaic infection is noticed early in the season. Keeping aphids under control may reduce spread of the virus.

NEMATODES — **See page 32.**

INSECT CONTROL

Consult the label before combining any insecticide with fixed copper.

LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Apply sprays at 7- to 10-day intervals in July and early August. Also control weeds in headlands, ditchbanks, roadsides etc., and control leafhoppers on adjacent carrots and lettuce. To help slow down the rate of resistance, alternate the use of insecticides from the various groups. Spray with one of:

Group A (Synthetic Pyrethroids)

1. cypermethrin
   (i) Cymbush 250 EC 140 mL (7 days)

Group B (Organo-Phosphates)

1. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (21 days)
   (ii) [3]Parathion 960 EC 225-375 mL (15 days)
   Note: To avoid excessive residues, do not use parathion more than twice during the growing period.
2. malathion
   (i) Malathion 25 WP 4.5 kg (7 days)
   (ii) Malathion 500 E 2 L (7 days)

Group C (Carbamate)

1. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 L (5 days)

CARROT WEEVIL

1. phosmet
   (i) Imidan 50 WP 2.25 kg (40 days)

TARNISHED PLANT BUG — Spray with one of the materials listed for Leafhopper control, or use:

1. endosulfan*
   (i) Thiodan 50 WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Endosulfan 400 EC 2.1 L (14 days)
   **Trim the celery*

APHIDS — Spray with one of:

1. naled
   (i) Dibrom 8.64 EC 1.7 L (4 days)
2. endosulfan*
   (i) Thiodan 50 WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Endosulfan 400 EC 2.1 L (14 days)
   **Trim the celery*
   Note: The green peach aphid is becoming resistant to these insecticides in some areas.

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. Bacillus thuringiensis
   (i) Thuricide 4.5 L (0 days)
2. endosulfan*
   (i) Thiodan 50 WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Endosulfan 400 EC 2.1 L (14 days)
   **Trim the celery*
3. naled
   (i) Dibrom 8 E 1.1 L (4 days)

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[2]*Minimum period before re-entry is 48 hours.*
[3]*Minimum period before re-entry is 7 days.*

STORAGE

Celery badly damaged by frost, disease, or handling should not be stored. A relative humidity of 95 to 98% and a temperature of 0°C are ideal. Celery should be stored in a room that is free from **odours** because the plant absorbs foreign flavours. Field heat should be removed, by hydro-cooling or vacuum-cooling, before placing in large storage rooms.

Handling diseased or healthy plants *using rubber gloves* will prevent the development of severe skin rashes in some individuals.

CORN (SWEET)

CULTIVARS
(Revised for 1992)

DTH	CHU	CULTIVAR	TYPE	COLOUR	EASE OF SNAP	APPEARANCE	FLAVOUR/ TENDERNESS	YIELD %
55	1600	Earlivee	su	Y	2.6	3.7	3.2	93
56	1700	Precocious	se	Y	3.5	3.9	4.3	98
62	1700	Seneca Horizon	su	Y	4.5	3.6	3.1	96
63	1750	Maple Sweet	se	Y	3.3	3.5	4.5	94
64	1800	Kiss and Tell	se	BC	4.0	3.8	3.9	100
65	1800	Tri-Sweet	se	BC	3.7	3.3	4.0	94
65	1800	Sugar Buns	se	Y	3.4	3.8	4.7	98
67	1800	Extra Early Super Sweet	sh_2	Y	3.7	3.4	3.1	95
67	1950	Sparkle Sweet	se	BC	3.7	4.1	4.0	96
68	1900	Burgundy Delight	su	BC	3.4	3.4	3.7	113
68	1800	Stars' N Stripes	se	BC	3.9	3.9	3.5	95
70	1800	Champ	se	Y	3.8	4.3	3.4	114
70	1950	Tuxedo	se	Y	3.6	3.7	4.0	105
70	1900	Top-Notch	sh_2	BC	3.4	4.0	3.8	97
72	1950	Bodacious	se	Y	3.9	4.2	4.1	110
75	1950	Norgold	su	Y	4.0	3.7	4.0	103
76	2000	Alpine	se	W	3.7	4.1	3.8	125
77	2050	Sweeter-By-Far	sh_2	BC	3.9	3.4	4.2	103
78	2050	Twilight	se	BC	4.2	3.9	3.7	80
79		Yankee Belle	sh_2	Y	3.9	3.7	3.5	92
79	2000	Silverado	se	W	3.8	3.8	3.6	100
79	2100	Sugar Ace	su-sh_2	Y	3.7	4.0	4.1	110
80		Dazzle	sh_2	BC	3.9	4.1	4.0	110
80	2000	Calico Belle	se	BC	3.4	3.6	3.5	115
80	2000	Candy Store	sh_2	BC	3.4	3.5	4.2	112
82	2050	Zenith	sh_2	Y	3.4	3.8	4.0	109
84	2050	Golden Jubilee	su	Y	2.9	3.5	3.3	104
84	2050	Escalade	sh_2	BC	3.9	3.3	4.2	97
86	2150	Flavourvee	su	Y	4.0	3.7	4.0	106
94	2250	Silver Queen	su	W	3.3	3.8	3.7	100

Days to Harvest* — are the days listed in the seed catalogue. They do not accurately represent the actual days between planting and harvest. In May a cultivar may require 85 days to mature, whereas the same cultivar planted in June might only need 65 days.

Corn Heat Units (CHU's)* — are values that indicate the accumulation of temperature (heat), required to mature a sweet corn cultivar. Not all cultivars have been rated for their CHU requirements.

*For more information on Days To Harvest, and CHU's, consult: **OMAF Factsheet, *Scheduled Planting of Sweet Corn*, Agdex 253/22.**

Type* — refers to the gene type of the cultivar. There are 3 main types of sweet corn.

Normal Sweet Corn: Are the traditional cultivars that have been available for years. These cultivars contain the **'su'** gene. They have normal sugar levels and convert their sugar to starch quite quickly.

Sugar Enhanced Sweet Corn: Contain the **'se'** gene. They have higher sugar levels and they also convert their sugar to starch. But because they have higher sugar levels to start with, they remain sweeter longer.

Supersweet Sweet Corn: Contain the **'sh_2'** gene. They often have the highest sugar levels of all 3 types. They do not convert sugar to starch readily and therefore stay sweet the longest. Cultivars with the 'sh_2' gene tend to be more difficult to grow.

Breeders are now releasing cultivars with combinations of the 3 gene types to improve seed vigour.

Colour* — Each of the above 'types' of sweet corn come in 3 different colours:

Y — all of the kernels on the cob are **yellow**
BC — kernels on the cob are both yellow and white **(bicolour)**
W — all of the kernels on the cob are **white**

*For more information on the 'Types' and 'Colours' of sweet corn cultivars, consult: **OMAF Factsheet, *High Sugar Sweet Corn*, Agdex 253/30.**

CORN (SWEET) (Continued)

Ratings are: 1 = poor, 5 = excellent
for: — Ease of snapping
— Appearance — Includes a combination of unhusked appearance, ear tip cover, and tip fill.
— Flavour

SEEDING AND SPACING

Eleven to seventeen kilograms of seed are required to plant one hectare depending on seed size. Where small seed is used the lower amount is sufficient. Minimum soil temperature for germination depends on the cultivar and its gene type. In general, su cultivars require 13°C, se's 16°C, and sh_2's 18°C.

EARLY CULTIVARS — Rows as close as 75 cm, plants 20 to 22 cm apart.

TALL, LATE CULTIVARS — Rows 95 cm apart, plants 22 to 25 cm apart.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — 90 kg N/ha is recommended. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — A portion of the nitrogen and phosphorus required should be applied at seeding in one of two ways:

1. In a band 5 cm to the side and 5 cm below the seed. The rate of application in the band should not supply more than 75 kg nitrogen/ha or a total of 120 kg of nitrogen plus potash (K_2O) per hectare in 75-cm rows. If urea is the nitrogen source, not more than 40 kg nitrogen or 80 kg of nitrogen plus potash/ha should be applied, in 75-cm rows.
2. In a band directly with the seed. With this placement not more than 9 kg nitrogen plus potash (K_2O)/ha should be applied, in 75-cm rows. A major portion of the nitrogen should be applied pre-plant or side-dressed before the corn is 30 cm high. A major portion of the phosphate and potash may be broadcast and worked in either in the fall or before seeding in the spring.

MICRONUTRIENTS — ZINC deficiency occurs occasionally in corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Where zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 12 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at seeding. Zinc may be applied as a spray at rates supplying 0.3-0.7 kg zinc/ha in 300 litres of water. A wetting agent should be added.

BIRD AND ANIMAL CONTROL

RED-WINGED BLACK BIRDS AND CROWS — Acetylene exploders are effective but birds will soon resume feeding when exploders are not operating. For full effectiveness locate them above the cornstalks, and move them around frequently. Constant patrolling and shooting during morning and evening feeding periods is effective but expensive. Plant away from marshy and wooded areas. Cultivars with ears well-covered by husks are somewhat resistant to blackbirds.

Av-Alarm electronic bird-scaring devices have sometimes been used successfully to repel large flocks of birds from fields of sweet corn.

RACCOONS AND SKUNKS — Shoot or trap in season. Plant the crop away from wooded areas. An electric fence with three strands placed at 8- to 10-cm intervals from the ground has given satisfactory control.

DISEASE CONTROL

SEED DECAY — Treat seed with thiram or captan seed protectant.

LEAF BLIGHTS, STALK ROTS, EAR ROTS — Rotate corn with unrelated crops such as peas, carrots, potatoes, beans and tomatoes. Plow under old cornstalks and leaves. Maintain well-balanced soil fertility.

COMMON SMUT — Crop rotation (4 years) may be helpful. Plant sweet corn following a legume such as alfalfa, clover, or beans. Do not plant sweet corn after field corn.

HEAD SMUT — This disease was first found in Ontario in 1979 and is easily confused with common smut. Follow recommendations given for common smut. The head-smut fungus survives in the soil for several years. For detailed information, **consult OMAF Factsheet, *Head Smut of Corn*, Agdex 111/632.**

INSECT CONTROL

SEED MAGGOTS AND WIREWORMS — Treat seed with diazinon, lindane and a fungicide. **See Chemical Seed Treatment, page 30.**

CORN EARWORM AND FALL ARMYWORM — These two late-season pests are not known to overwinter in Ontario. Instead, they are carried by winds across the Great Lakes from the United States. The fall armyworm generally first appears in late July to early August, while the corn earworm blows in from early August to mid-September. The larvae of both species attack the ear causing economic injury to late-planted fresh market and processing sweet corn. Both pests are monitored by O.M.A.F. as part of the Provincial Pest Alert Program. For activity information call your local agriphone and monitor fields carefully for young larvae in ears. Effective control has been obtained by using one of the synthetic pyrethroids directed at the ear zone.

The following recommendations when applied for corn earworm control will also control the fall armyworm.

1. cypermethrin
   (i) Ripcord 400 EC 175 mL (5 days). Maximum of 3 ground applications or 2 aerial applications per year.
2. permethrin
   (i) Ambush 500 EC 200-275 mL (1 day)
   (ii) Pounce 384 EC 275-375 mL (1 day)
3. [1]methomyl
   (i) [1]Lannate L 1.8-2.6 L (3 days)

APHIDS — Methomyl and parathion, as applied to control European corn borer, will also provide some control of aphids.

CORN ROOTWORM — Where corn rootworm has been a problem, crop rotation is recommended. For adult control,

CORN (SWEET) (Continued)

products used for European Corn Borer control will reduce populations of rootworm adults.

1. carbofuran
   (i) Furadan 480 F 0.5 L/ha (7 days)

EUROPEAN CORN BORER — This insect is the major pest of sweet corn in Ontario. There are 2 generations of corn borer per year in Essex, Kent, and Norfolk counties. Generally, there is only one generation per year throughout the rest of the province. In the 2-generation area, corn borer adults are most abundant in June and August, with August having the greater number. In the 1-generation area, most corn borer adults are present in July.

In Ontario, O.M.A.F. co-ordinates a monitoring program called Pest Alert which uses pheromone traps and degree day modelling to detect first activity of European corn borer. Updates are provided on a regular basis on local O.M.A.F. agriphones.

Sweet corn is susceptible to corn borer from the late whorl stage (12-14 leaves emerged and when the tassel can be felt inside the whorl) until the silks dry. If corn borer adults are present during this time, then the field should be inspected weekly for egg masses and/or pinhole feeding.

Eggs are white and are laid in masses containing 5-50 eggs that resemble overlapping fish scales. They are most often laid on the underside of the upper leaves, near the midrib. Early larvae feed on the leaves, making several small feeding holes in one area (pinholes). However, since monitoring for egg masses is difficult and time consuming, the initiation of a spray program is usually based on the presence of this pinhole feeding, detected through field inspections. Apply an insecticide when pinhole feeding is observed in at least 5% of the plants. If the tassel has not yet completely emerged, spray down into the whorl. After that time, direct the spray toward the ear zone.

Application at 5-day intervals usually gives satisfactory control. This interval may vary with temperature and material used (consult manufacturer's label directions). Check local agriphone recommendations to find out when the corn borer generation ends and sprays are no longer needed.

To reduce the threat of major corn borer infestations rotate your sweet corn planting with other vegetable crops and keep grassy weeds bordering fields and in ditch banks under control.

Spray with one of:

1. permethrin
   (i) Ambush 500 EC 200-275 mL (1 day)
   (ii) Pounce 384 EC 275-375 mL (1 day)
2. cypermethrin
   (i) Cymbush 250 EC 280 mL (5 days)
   (ii) Ripcord 400 EC 175 mL (5 days)
3. carbaryl
   (i) Sevin XLR Plus 2.5-4.0 L (1 day)
4. [2]carbofuran
   (i) [2]Furadan 480 F 1.1 L (7 days)
5. methomyl
   (i) [1]Lannate L 2.6 L (3 days) (Shorten spray interval to 3 days under high pressures and rainy weather conditions.)

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[1]*Minimum period before re-entry is 24 hours.*
[2]*Minimum period before re-entry is 48 hours.*

BEE WARNING

Bees often visit sweet and field corn to collect pollen. Where spraying is being done, bee poisoning may result. **Carbaryl, carbofuran and permethrin are highly toxic to bees** but **carbaryl** is the most damaging since it is carried to the hive and poisons the brood. If bees are in the area advise the local beekeepers of spraying activity and do not use carbaryl. **Your local Agricultural Representative has a list of beekeepers in your area.** Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid spray drift to roadsides and adjacent fields where plants might be in bloom.

CUCUMBER (FRESH MARKET), MUSKMELON, WATERMELON, PUMPKIN AND SQUASH

VINE-CROP CULTIVARS
(Revised for 1992)

CUCUMBER (listed alphabetically)	
Dasher II	Raider
Highmark II	Southern Set
Marketmore 76	Slicemaster
Medalist	Sprint 440
Monarch	Ultra Slice
MUSKMELON	
Burpee Hybrid	Roadrunner
Market Star[1]	Canada Gem Hybrid
Early Dawn	Saticoy Hybrid[1]
Rising Star	Nova
Samson[1]	Summet[1]
Pulsar *(trial)*	Supermarket[1]
WATERMELON	
Dixie Lee	*Long-Oblong for*
Sugar Baby	*long-season areas*
Crimson Sweet	Royal Jubilee
Blue Belle	Charleston Gray 113
Mirage *(trial)*	Royal Sweet
	Prince Charles
PUMPKIN	
Jack-O-Lantern	Baby Pam
Howden	Spookie
Happy Jack	Small Sugar
Pankow's Field	Autumn Gold
SQUASH (WINTER)	
Waltham Butternut	Royal Acorn
Hercules	Hubbard (Golden, Blue, Green)
Kindred	Delicious
Buttercup	Boston Marrow
SQUASH (SUMMER)	
Cocozelle	Zucchini Select
White Bush Scallop	Zucchini Elite

[1]*Resistant to powdery mildew*

Consult OMAF Factsheet, *Muskmelon Production,* Agdex 256/20.

SEED TREATMENT

Treat seed with a fungicide such as thiram or captan according to the manufacturer's directions.

PLANTING MELONS

Early muskmelon crops are usually started in hotbeds or greenhouses five weeks before transplanting outdoors.

About three seeds are sown 2.5 cm deep in sterile soil in 10 x 10-cm bands, or 10-cm clay, plastic, or peat pots. Seedlings are thinned to two per pot.

Germination temperature should be 27 to 29°C until seedling emergence, then 16 to 18°C minimum night temperature.

The plants should be set in the field with a starter solution. When transplants are set with more than 3 true leaves, slow stunted growth will result with poor yields. Watermelons may be treated in a similar manner.

MULCHING MELONS

Mulching melon transplants or seeding directly through mulches of black polyethylene or plastic-coated paper has proven beneficial because of an increase in early and total yield. These mulches also conserve moisture, control weeds, accelerate maturity by increasing soil temperature, and reduce fruit rots.

The polyethylene films are usually black or some other dark **colour** in order to control weeds. If a clear film is used, a preemergence herbicide must be incorporated into the soil before laying the mulch. Mulching materials are usually 1.5 mm thick and usually come in 90- or 120-cm-wide rolls. A tractor-mounted machine lays the mulch and covers the edges with soil. If the rows are 1.9 m to 2.2 m apart, 5,260 m or 4,550 m of mulch is required, respectively, per hectare. Commercial machines are available to transplant plants in peat pots through the mulch. There are also seeders that can plant through the mulch.

The use of photo-degradable mulches that disintegrate in the presence of light eliminates the need for removing the mulch from the soil after harvest.

SEEDING AND SPACING

About 2.2 kg of seed are required to produce enough cucumber and muskmelon transplants for one hectare. For direct seeding of cucumbers and melons 4.5 to 5.5 kg of seed per hectare are required.

SQUASH AND PUMPKIN seeding rates vary somewhat with seed size. Large-seeded cultivars such as Blue Hubbard will require 3.5 to 4.5 kg per hectare and small-seeded cultivars such as Butternut 1 to 1.5 kg per hectare.

CUCUMBER — Rows 1.2 to 1.8 m, plants 30 cm apart.

MUSKMELON — Rows 1.5 to 1.8 m, plants 60 to 120 cm apart.

WATERMELON — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (STANDARD) AND WINTER SQUASH — Rows 1.8 to 2.5 m, plants 90 to 120 cm apart.

PUMPKIN (BUSH) AND SUMMER SQUASH — Rows 90 to 120 cm, plants 60 to 90 cm apart.

POLLINATION

All the vine crops depend on insects to transfer pollen from the male to the female blossoms, which are borne separately on the same plant. In small plantings there may be sufficient native pollinating insects to perform this service. In large plantings, the grower would be well advised to introduce one colony of honeybees for every hectare to ensure adequate pollination. Insecticides will poison bees. **See warning on page 50 Re: Bee Poisoning.** **Consult OMAF Factsheet, *Pollination of Vine Crops,* Agdex 256/26.**

CUCUMBER (FRESH MARKET), MUSKMELON, WATERMELON, PUMPKIN AND SQUASH (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application **(See tables on pages 17 and 19).**

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of $(N + K_2O)$/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run, especially following heavy rains.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

DAMPING-OFF — Treat seed with a captan or thiram seed protectant. Sterilize soil for growing seedlings.

BACTERIAL WILT — The causal bacteria overwinter in and are spread by cucumber beetles which feed on cucumbers and other vine crops. Plants may become infected soon after they emerge when the crop is field seeded, or after transplants are set in the field and for the following three to five weeks. Beetles must be controlled (see Cucumber Beetles).

ANGULAR LEAF SPOT (cucumber) — It is not possible to completely control this disease with chemical sprays. A reduction in disease severity may be achieved by spraying with a fixed-copper fungicide. Repeat at weekly intervals in wet weather. Do not work in crop when foliage is wet.

1. fixed copper
   (i) Copper 50 W 3.25 kg (1 day)

FUSARIUM WILT (muskmelon) — Sterilize soil for melon transplants. Grow Fusarium-resistant cultivars in infested soils (consult seed catalogue).

MOSAIC (VIRUS) — Grow cultivars reported to be highly resistant to mosaic (cucumber cultivars show a range of resistance). Consult seed catalogue. Since the virus is transmitted by aphids, spray or dust to control them (see Aphids). Because the virus overwinters in such perennial weeds as milkweed, ground cherry, pokeweed and motherwort, destroy nearby weeds in fencerows and waste areas.

ALTERNARIA LEAF SPOT — This disease is often prevalent in muskmelons. The oldest leaves are infected first. Sprays applied to control scab and anthracnose are somewhat effective.

SCAB (cucumber) — Where susceptible cultivars are grown, scab is often serious. Do not plant cucumbers following cucumbers. Beyond the seedling stage spray with one of:

1. chlorothalanil
   (i) Bravo 500 4.8 L (1 day)
2. mancozeb
   (i) Dithane DG 3.25 kg (14 days)
   (ii) Dithane M-45 3.25 kg (14 days)
   (iii) Manzate 200 3.25 kg (14 days)
3. benomyl
   (i) Benlate 50 WP 550-850 g + mancozeb (see above)

ANTHRACNOSE (muskmelon and watermelon) — Do not plant melons following melons. Spray seedlings as described above for control of scab on cucumbers. Beyond the seedling stage spray with one of:

1. anilazine
   (i) Dyrene 50 WP 3.75 kg (1 day)
2. chlorothalanil
   (i) Bravo 500 4.8 L (1 day)
3. mancozeb
   (i) Dithane DG 3.25 kg (14 days)
   (ii) Dithane M-45 3.25 kg (14 days)
   (iii) Manzate 200 3.25 kg (14 days)

POWDERY MILDEW — Some cucumber and muskmelon cultivars are moderately resistant to mildew. As soon as mildew appears, spray with one of the following at 8- to 10-day intervals:

1. chlorothalanil
   (i) Bravo 500 4.8 L (1 day)
2. benomyl
   (i) Benlate 50 WP 550-750 g + mancozeb (see above for anthracnose) (14 days)

NEMATODE CONTROL (See page 32)

INSECT CONTROL

SQUASH VINE BORER (on squash) — Four insecticide applications one week apart starting in late June are required. Spray base of plants thoroughly with one of the following:

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. rotenone
   (i) Rotenone 5 WP 4.5 kg (1 day)

Dust:

1. rotenone
   (i) Rotenone 1 WP 40 kg (1 day)

Butternut squash is resistant to squash vine borer.

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. See Chemical Seed Treatment, page 30.

CUTWORMS — See page 28.

CUCUMBER BEETLES — Spray or dust when plants are breaking through (repeat if beetles re-appear) with one of the following:

CUCUMBER (FRESH MARKET), MUSKMELON, WATERMELON, PUMPKIN AND SQUASH (Continued)

Spray:

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.5 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (6 days) (use on cucumbers only)
   (ii) [2]APM 50 WP 1.1 kg (6 days)
   (iii) [2]Azinphos Methyl 240 EC 2.3 L (6 days)
   (iv) [2]Guthion Solupak 50 WP 1.1 kg (6 days)

Dust:

1. rotenone
   (i) Rotenone 1% WP 40 kg (1 day)

Or use a commercial cucumber or melon dust containing an insecticide and fungicide.

APHIDS — Spray with one of the following which are listed in order of best control:

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. malathion
   (i) Malathion 25 WP 3.25-4.5 kg (1 day, 3 days pumpkin)
3. [2]oxydemeton-methyl
   (i) [2]Metasystox-R 240 SC 1.75-2.25 L (14 days, 7 days watermelon)

SQUASH BUG (more common on squash and pumpkin) — Use one of the following:

Spray:

1. methoxychlor
   (i) Methoxychlor 50 WP 3.25 kg (1 day)
2. rotenone
   (i) Rotenone 5 WP 4.5 kg (1 day)

Dust:

1. rotenone
   (i) Rotenone 1 WP 40 kg (1 day)

THRIPS AND LEAFHOPPERS — Spray or dust with methoxychlor, rotenone, or malathion at rates given for other insects.

TWO-SPOTTED SPIDER MITE — Spray with:

1. dicofol
   (i) Kelthane 35 AP 1.1-1.75 kg (7 days)

SAP BEETLES (melons) — Beetles infest and damage ripening fruit where the stem is attached to the vine and where the skin is diseased or injured. To reduce beetle injury, harvest the melons as often as possible at the half-slip stage. Remove all damaged fruit and culls from the field.

CORN ROOTWORM BEETLES — Materials, when used to control cucumber beetles will provide short-term control of corn rootworms.

TARNISHED PLANT BUG — Endosulfan, when used for the control of cucumber beetles will provide some control of tarnished plant bug.

[2]*Minimum period before reentry is 48 hours.*

Bee Warning

These insecticides, except rotenone, poison bees. Apply insecticides other than rotenone early in the day or in the evening when bees are not working in the field. If hives are in the crop, remove them when treating the field.

CURING AND STORING PUMPKIN AND SQUASH

Most pumpkins do not keep as well as hard-shelled winter squashes but if properly handled they can be kept until after Christmas. All winter squashes should be well-matured, carefully handled and free from injury or decay when stored. Unlike most other vegetables, squashes and pumpkins require warm, fairly dry storage with good air circulation. The fruit can be placed preferably on racks, leaving a small space between each fruit or they can be placed in bulk bins and baskets. Pumpkins and winter squashes are best stored at 10-13°C with a relative humidity (RH) of 50-70%. Temperatures that are too low in storage will cause a very rapid breakdown and rotting of fruit.

Butternut squashes should keep 2 to 3 months at 10°C with 50% RH after which time spoilage and shrinkage increase. Weight loss should be kept below 15%. Buttercup squashes should keep at least 3 weeks. Hubbard squashes can be stored up to 6 months at 10-13°C with 70% RH.

Curing the fruit for 10-20 days at 24°-27°C can decrease the higher water content of the fruit and improve the eating quality. Butternut, Hubbard and Delicious cultivars respond to this treatment but storage life may be shortened. Curing acorn-type squashes decreases the storage life and eating quality.

CUCUMBER (PROCESSING)

CULTIVARS
(Revised for 1992)

Hand-Pick		Once-Over
Earlipik 14	Score	Flurry
Premier	Flurry	Pik-Rite
Pioneer	Carolina	Spear-It
Pik-Rite	Fancipak	Calypso
		Napoleon
		Discover *(trial)*

All the cultivars listed are hybrids that have a predominately female flowering habit. A true gynoecious cucumber bears only female flowers. However, not all hybrids produce 100% female flowers. As many as 80% of the plants of many new hybrids may have some male flowers in Ontario fields. Our environment (e.g. daylength and temperatures) may be responsible for the presence of male flowers on these hybrids. From 10 to 15% of the seed sold as a gynoecious hybrid is a standard or monoecious cultivar, added as a pollinator. For satisfactory fruit set, 10 to 20% of the plants should contain a large number of male flowers.

The cultivars listed are recommended based on their suitability for either hand-pick or once-over mechanical harvesting. The hand-pick cultivars have performed well in trials and on growers' fields over the past several years. They include black and white-spined cultivars. Black-spined cultivars turn yellow as they reach maturity or if they are under stress. White-spined cultivars maintain their green color independent of stage of maturity and are preferred for once-over mechanical harvesting. The once-over cultivars listed are white-spined. All of these cultivars were bred especially for once-over harvesting of high plant populations.

SEED TREATMENT

See Cucumber (Fresh Market). Seed provided by processors is usually treated with a seed protectant.

PLANTING

Pickling cucumbers are usually field-seeded from late May to early June for the hand-pick crop but for once-over mechanical harvesting, seeding can be done until mid-July. Quick uniform emergence is essential to avoid uneven stands and stands weakened by insects and disease. Because of a more uniform depth of seeding and spacing of the seed, precision seeding tends to reduce plant stress and promote more uniform crop emergence and development. Cucumber seeds will not germinate at a soil temperature below 10°C, germinate slowly at 20°C, with fastest germination at 25 to 30°C soil temperature. Delay seed sowing until the soil temperature is 15°C or higher. Seeding depth will vary depending on moisture. A soil cover of 20 to 25 mm is usually adequate. Cucumber seed should never be planted deeper than 25 mm.

SPACING

For the hand-harvested crop, rows are usually spaced 1.1 to 1.2 m apart with 6 to 10 plants per metre of row. This gives plant populations ranging from 50,000 to 90,000 plants per ha. These spacings require from 1.7 to 3.0 kg of cucumber seed per ha. With average germination conditions, 1.0 kg of cucumber seed will give approximately 30,000 plants. Close spacing, rows 75 cm apart, have been successfully used by some growers. In general, the closer the spacing the higher the yield. However, very close spacing may present problems at harvest due to excessive vine, depending on cultivar, soil type and amount of rainfall.

For the once-over machine-harvested crop, the plant population for optimum yield will depend on soil type and availability of irrigation. Without irrigation, populations of 150,000 per ha are adequate. This population can be achieved by spacing rows 70 cm apart with 10 plants per metre of row and will require 5.0 kg of seed per ha. Higher populations, up to 200,000 plants per ha, can be achieved by spacing rows 50 cm apart with 10 plants per metre of row, requiring approximately 7.0 kg of seed per ha.

POLLINATION

With the use of hybrids and high plant populations, the provision of bees for pollination becomes extremely important. One honeybee colony per 50,000 plants during the blooming period is suggested. Insecticides will poison bees. **See warning Re: Bee Poisoning on page 50. Consult OMAF Factsheet, *Pollination of Vine Crops*, Agdex 256/26.**

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 110 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — Broadcast 65 kg N/ha and all of the phosphate and potash required before planting and work in. Alternatively, up to 100 kg of $(N + K_2O)$/ha can be applied in a band, 5 cm to the side and 5 cm below the seed at planting with the remainder of the fertilizer broadcast before planting.

The remainder of the N should be side-dressed before the vines begin to run, and on sandy soils a second application may be necessary after the vines begin to run if rainfall is excessive.

IRRIGATION — If the nitrogen is applied through the irrigation system, no more than 20 kg N/ha per application should be used.

DISEASE CONTROL

ANGULAR LEAF SPOT — Persistence of angular leaf spot in the field is a major problem. Infection of fruit is readily visible in the processed product. See Cucumber (Fresh Market).

SCAB — Grow scab-resistant cultivars. All pickling cultivars listed above are scab resistant. Also see Cucumber (Fresh Market).

OTHER DISEASES — See Cucumber (Fresh Market).

INSECT CONTROL

See Cucumber (Fresh Market).

EGGPLANT

CULTIVARS
(Revised for 1992)

BELL TYPES	CYLINDRICAL TYPES	SCICILLIAN TYPES
Highbush Select	Mirabel	Murena
Classic	Vernal	Black Bell
Epic	Mini Fingers	Black Beauty
Jersey King		Italian Pink Bicolour
Special Hibush		
Dusky		
WHITE	**MINI**	
Ghost Buster	Baby Bell	
Casper	Little Fingers	

SEED TREATMENT

Sow hot-water-treated seed **(See page 30).** Before sowing, dust seed with thiram seed protectant.

SEED AND SPACING

One hectare with rows 90 to 120 cm apart and plants 45-60 cm apart will require 200-300 grams of seed.

GROWING THE PLANTS

Because eggplant requires a long growing season, it is started in a greenhouse or hotbed. The seed is sown in shallow flats of soil 9 to 10 weeks before field transplanting because the seed germinates slowly. Germinate seed at 27 to 29°C in flats of sterilized soil or whatever sterile medium is used for growing seedlings. It is important that the young plants are not checked in growth by cool temperatures, drought, cold drafts, or other causes. It is advisable to transplant the young plants to pots or bands before field setting to keep transplanting shock to a minimum.

Eggplants are hardened in the same way as peppers except that a higher temperature (18 to 21°C) is maintained.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed, 3 to 4 weeks after field setting.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or on dry sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment. Sow and transplant in steamed or fumigated soil. Drench flats at time of first watering with captan 50 WP (see label). When first true leaves develop, spray with captan and repeat every 7 to 10 days. Apply sufficient spray to wet the plants and run down the stems. **(See Damping-Off, page 30).**

VERTICILLIUM WILT — Sow and transplant in steamed or fumigated soil. Do not plant in fields where Verticillium wilt has been present unless the soil is treated with Vorlex 450 L/ha, according to manufacturer's directions. Good weed control is an important part of wilt control. Wilt may be serious following peppers, tomatoes, eggplant, potatoes, strawberries and raspberries.

PHOMOPSIS BLIGHT — Avoid planting in infested fields for three years.

NEMATODES — **See page 32.**

INSECT CONTROL

FLEA BEETLES — Spray plants just before field setting with one of the following insecticides. Repeat in the field if beetles appear.

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.5 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. carbaryl
   (i) Sevin XLR Plus 1.25 L (2 days)

APHIDS — Spray with one of:

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)

   The green peach aphid is resistant to these insecticides in some areas.

TARNISHED PLANT BUGS — Monitoring for tarnished plant bug should begin at time of flowering.

Spray:

1. dimethoate
   (i) Cygon 480 E 0.7-1.7 L (7 days)

COLORADO POTATO BEETLE

Spray:

1. carbaryl*
   (i) Sevin XLR Plus 1.25 L (2 days)

   **Repeat as necessary.*
2. endosulfan
   (i) Thiodan 50 WP 1.1-2.25 kg (2 days)
   (ii) Thiodan 4 EC 1.5-2.75 L (2 days)

GARLIC

CULTIVARS

Cultivated garlic plants do not produce true seed. All garlic is propagated vegetatively. Two types of garlic are grown in Ontario and are described as either 'hardneck' or 'softneck'. For seed sources consult a Horticultural Crop Advisor.

SEEDING AND SPACING

The optimum planting date is from September to late October. To estimate the planting date, use the average date for the first fall frost for the area in which garlic is to be grown and begin planting on this date. See Table 11.

RATE — 700 to 1000 kg of cloves per hectare.

DEPTH OF PLANTING — Allow for 3 to 5 cm between the soil surface and the top of the clove.

ROW SPACING — Row centers of 20 cm or more depending upon equipment available; 7 to 12 cm apart within the row.

SOILS

Garlic can be grown on a wide range of soil types providing that the soils are well-drained, deep and fertile. Soils with good organic matter content are preferred due to the increased moisture and nutrient holding capacity. Extremely heavy soil types should be avoided. Soil pH should range from 6.0-7.5.

FERTILIZER

To establish pH, phosphorus and potassium requirements, a soil test should be used. pH, phosphorus and potassium levels should be used amended prior to fall planting. Phosphorus and potassium requirements are similar to onions.

NITROGEN — On mineral soils, a total of 110 kg/ha is required. Calcium nitrate or ammonium nitrate are the preferred sources. Half of the nitrogen should be applied as soon as the garlic plants begin to grow in the spring. The rest of the nitrogen should be applied in 2 to 3 sidedresses at 3 week intervals.

IRRIGATION

Garlic is shallow-rooted and is sensitive to moisture stress. For most soil types approximately 2.5 cm of water is required per week. On very dry sandy soils, as much as 5.0 cm is required weekly.

DISEASE CONTROL

PENICILLIUM OR GREEN MOLD DISEASE — Green mold disease, caused by the fungus Penicillium, attacks cloves which have been damaged prior to planting. Affected cloves may fail to emerge in the spring, or may produce weak, stunted plants which soon die. Plant only clonal cultivars known to be vigourous under Ontario growing conditions. Avoid damaging the seed cloves, especially during the cracking procedure. Many mechanized cracking devices cause excessive amounts of clove damage. Crack the seed immediately before it is to be planted. The cracked cloves may be treated with:

1. iprodione
   (i) Rovral 50 WP 4 g/L of water

Note: Dip cloves into the Rovral suspension prior to planting.

INSECT CONTROL

APHIDS AND THRIPS

1. malathion
   (i) Malathion 25 WP 4.25 kg (3 days)
   (ii) Malathion 500 E 2 L (3 days)

ONION MAGGOTS

1. chlorpyrifos
   (i) Lorsban 4E 3.5 L in 1000 L of water (50 days)

Note: Apply as a drench over the row on newly emerged plants (in the spring).

For further details, **consult OMAF Factsheet, *Garlic Production in Ontario*, Agdex 258/13.**

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

LETTUCE

CULTIVARS
(Revised for 1992)

CRISPHEAD
(i) *TRANSPLANTS*
Ithaca
(ii) *SEEDED*
Ithaca (early, mid, late)
Mesa 659 (late)
Montello (mid, late)
Green Lake (mid, late)
Salad Crisp *(trial)*

LEAF
Black-Seeded Simpson
Grand Rapids Forcing
Deep Red

BOSTON AND BUTTERHEAD
Buttercrunch
Summer Bibb
Dark Green Boston
Citation

COS OR ROMAINE
Paris Island Cos
Green Towers
Tall Guzmaine

TEMPERATURE

Lettuce is a cool-weather crop and makes its best growth at temperatures between 16 and 18°C. Production is limited on mineral soils to the transplanted early crop and the seed-sown late crop. On muck soils, in cooler areas such as Bradford, lettuce may be produced throughout the growing season.

Properly hardened transplants, when set in the field in the early spring, can tolerate temperatures as low as -7°C. For the late crop on both muck and mineral soils seeding time is important. If plants are immature when the first frost occurs they will recover. Wrapper leaves on mature heads are very susceptible to frost and can only be marketed at a lower grade.

Germination occurs even at 4°C. At very high soil temperatures (27°C or above), germination is delayed.

SEED TREATMENT

See Chemical Seed Treatment (page 30).

PLANTING

TRANSPLANTS — Start transplants in the greenhouse about 4 weeks before the date that they will be planted in the field. Grow transplants in flats or plug trays using pasteurized soil or a soilless greenhouse mix. Sow one seed per cell. Even watering and fertilization is critical in plug transplant production.

Harden plants and thoroughly soak soil with starter solution (20-20-20) before transplanting in the field.

DIRECT-SEEDING — Sow seed in spring as soon as soil is ready. The rate is 1 to 2 kg per hectare. Use coated or pelleted seed with a precision seeder. The stand and germination are more uniform, thinning costs are reduced, and higher percentages of cut are realized at harvest time.

SPACING — Leaf and butterhead cultivars 20 to 30 cm in rows about 30 cm apart. Crisphead lettuce 30 to 35 cm apart in rows about 40 cm apart.

THINNING — Thin when two or three leaves have formed.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS apply up to 110 kg/ha and on MUCK SOILS apply up to 120 kg/ha. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — On MINERAL SOILS broadcast half the nitrogen before planting and work in. Side-dress the balance 3 weeks after transplanting to the field or after thinning the seeded crop. On MUCK SOILS broadcast nitrogen at 70-90 kg/ha before planting and sidedress the remainder when the heads begin to form.

MICRONUTRIENTS — **COPPER** deficiency may show up on acid peat and muck soils. Copper may be mixed with the fertilizer and applied at 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

MANGANESE — Deficient lettuce shows marked yellowing between the veins; the veins themselves remain dark green. Manganese deficiency usually shows up on slightly acid or alkaline muck, peat and dark-colored sandy soils. Foliar applications, starting after thinning or transplanting, with manganese sulfate at rates supplying 1.0 to 2.0 kg manganese/ha in 3000 L of water, are recommended where manganese deficiency has been a problem. Soil application is not recommended for manganese because of the large amounts required.

DISEASE CONTROL

DAMPING-OFF — Steam or fumigate soil for growing transplants **(See Damping-off, page 30).**

BOTRYTIS — Spray greenhouse-grown seedlings with 76% ferbam WDG 2 kg/1000 L water, or dust with ferbam dust at 1-2 kg/100 m² of bed before first transplanting, and once or twice later at 10-day intervals (spray to wet plants only).

DOWNY MILDEW in coldframes, greenhouses and on late lettuce — Spray every 7 to 10 days with one of:

1. zineb
   (i) Zineb 80 W 2.25-2.75 kg (14 days)
2. maneb
   (i) Maneb 80 W 2.25-3.25 kg (14 days)

SCLEROTINIA (of lettuce, carrots, beans and celery) — Rotate with onions, beets or spinach for 2 to 3 years. Removal of crop refuse will help to control the disease. Use row and plant spacings to encourage good air movement or plant on raised beds.

CORKY ROOT ROT — Allow sufficient time between lettuce crops for the plant residues to decompose completely. Avoid applying excessive amounts of nitrogen, especially urea. Most Boston types have good resistance.

ASTER YELLOWS — See Leafhoppers (Insect Control section).

LETTUCE MOSAIC — Mosaic-indexed or mosaic-tested seed is available from most sources. This seed is produced in special areas where it is carefully checked to ensure that it is virtually free from seed-borne mosaic.

LETTUCE (Continued)

Control aphids as they spread the disease from infected lettuce plants and weeds such as groundsel, shepherd's purse, and lamb's-quarters.

NEMATODES — **See page 32.**

INSECT CONTROL

ASTER LEAFHOPPERS — Control leafhoppers because they spread aster yellows. Spray lettuce 4 to 5 times at 5- to 7-day intervals, starting when leafhoppers first appear. Leafhoppers must be controlled in older patches by spraying as close to harvest as possible to protect nearby young plantings. Also, spray weeds in headlands, ditchbanks, roadsides etc., and control leafhoppers on adjacent carrots and celery. After harvest, spray unmarketable heads and disk down 24 hours later.

To delay pesticide resistance, alternate the groups of insecticides listed.

Spray with one of:

GROUP A (Synthetic Pyrethroid)

1. cypermethrin
   (i) Ripcord 400 EC 125 mL (14 days)

GROUP B (Organo-Phosphates)

1. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (7 days head lettuce, 21 days leaf lettuce)
   (ii) [3]Parathion 960 EC 225-375 mL (5 days head lettuce, 21 days leaf lettuce)
2. malathion
   (i) Malathion 25 WP 4.5 kg (7 days head lettuce, 14 days leaf lettuce)
   (ii) Malathion 500 E 1.5-2.75 L (7 days head lettuce, 14 days leaf lettuce)

GROUP C (Carbamate)

1. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 L (5 days head lettuce, 21 days leaf lettuce)

OR apply phorate (Thimet 15 G) at 7.25 kg/ha in the fertilizer band on one or both sides of the row at seeding time, or when transplants are set in the field. See label for directions and cautions.

OR use disulfoton (Di-Syston 15 G) at 40-75 grams per 100 metres of row at seeding time, in a band on each side of the row. See cautions on the label. Do not use on transplanted lettuce. Use the higher rate on heavy and organic soils.

APHIDS — Spray with one of:

1. dimethoate
   (i) Cygon 480 E 0.7 L (7 days)
   (ii) Lagon 480 E 0.7 L (7 days)
2. pirimicarb
   (i) Pirimor 50 WP 300-500 g (7 days). (Do not apply Pirimor if lettuce is to be exported to the U.S.A.).
3. endosulfan*
   (i) Thiodan 4 EC 2 L (14 days) **(Not on leaf lettuce)**
   (ii) Endosulfan 400 2.1 L (14 days) **(Not on leaf lettuce)**
   (iii) Thionex 50 WP 1.75 kg (14 days head lettuce)
4. [3]*parathion
   (i) [3]Parathion 15% WP 2.25 kg (7 days head lettuce, 21 days leaf lettuce)
   (ii) [3]Parathion 960 E 350 mL (7 days head lettuce, 21 days leaf lettuce)
5. [2]methamidophos
   (i) [2]Monitor 480 EC 1.1-2.25 L/ha (14 days) **(Not on leaf lettuce)**

   **The green peach aphid may be becoming resistant to this insecticide.*
6. naled
   (i) Dibrom 8 E 1.1 L (4 days)
7. diazinon
   (i) Basudin 500 EC 1.1 L (10 days)

CABBAGE LOOPER — Spray when loopers first appear with one of:

1. Bacillus thuringiensis
   (i) Dipel WP 1.1 kg (0 days)
   (ii) Thuricide HPC 4.25 L (0 days)
2. [1]methomyl
   (i) [1]Lannate L 2.25-4.5 L (7 days) **(Not on leaf lettuce)**
3. [2]methamidophos
   (i) [2]Monitor 480 EC 1.25-2.25 L (14 days) **(Not on leaf lettuce)**
4. naled
   (i) Dibrom 8 E 1.1 L (4 days)
5. endosulfan*
   (i) Thiodan 4 EC 2 L (14 days) **(Not on leaf lettuce)**
   (ii) Endosulfan 400 2.1 L (14 days) **(Not on leaf lettuce)**
   (iii) Thionex 50 WP 1.75 kg (14 days head lettuce)

   **Do not apply more than 3 times per season.*

TARNISHED PLANT BUG

1. endosulfan*
   (i) Thiodan 4 EC 2 L (14 days) **(Not on leaf lettuce)**
   (ii) Endosulfan 400 2.1 L (14 days) **(Not on leaf lettuce)**

   **Do not apply more than 3 times per season.*

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[1]*Minimum period before re-entry is 24 hours.*
[2]*Minimum period before re-entry is 48 hours.*
[3]*Minimum period before re-entry is 7 days.*

ONION

CULTIVARS
(Revised for 1992)

COOKING* (seeded)

3 to 14 days later, in order of maturity

Early		
Eskimo	Tarmagon	Sweet Sandwich
Norstar	Trapp's No. 6	Russet
Rocket	Taurus	Copra
Columbia	Trapp's No. 8	High Score
Hustler	Capable	Sentinel (latest)
New York Early	Paragon	
	Bingo	
	Canada Maple	

SETS
- Ebenezer (White and Yellow)
- White Portugal
- Stuttgarter

BUNCHING
- Japanese Bunching
- Southport White Globe
- White Knight

PICKLING
- Pompei
- Barletta — pearl type
- Silver Queen — pearl type
- White Portugal — pearl type

TRANSPLANTS
- Sweet Spanish types (open pollinated)

For muck soils
- Brahma
- Cima
- Maya
- Fiesta
- Matador
- Bull ring

RED (in order of maturity)
- Ruby
- Southport Red Globe *(trial)*
- Red Wethersfield *(trial)*
- Benny's Red
- Carmen *(trial)*

**See Cultivar Descriptions for suitability for storage.*

CULTIVAR DESCRIPTIONS

Barletta — Used for pearl-onion processing.

Benny's Red — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, not for long storage.

Bingo — Very firm, high yield potential, good bulb size, suitable for long term storage.

Brahma — Large-bulbing, mid-season-maturing Spanish type, good resistance to bolting, high yield potential, good quality, light brown skin.

Bull ring — Sweet Spanish type, high percentage of single centres, excellent quality, large-bulbing, mid-season maturity.

Canada Maple — Bulbs very firm, medium to large, round, high yield, suitable for long-term storage.

Capable — Early maturing, high globe bulbs, yellow skin colour, suitable for long term storage, good tolerance to pink root.

Carmen — Red-skinned, late maturing, globe shaped, firm, high-scoring hybrid, suitable for storage.

Cima — High yield potential, high quality, Spanish jumbo type, good resistance to premature bolting, globe shaped, light brown skin, mid-late season maturing.

Columbia — Early maturing, very good yield, firm, suitable for storage.

Copra — Very firm, very late maturing, high yielding, excellent scoring, excellent for long-term storage.

Ebenezer — (White or Yellow) — White Ebenezer is used for very early, mild, green bunching onions. Yellow Ebenezer is a set-onion type for the production of cooking onions.

Eskimo — Very early maturing, good neck finish, medium size bulbs, suitable for short-term storage only.

Fiesta — Mid-season maturing, shallow globe, brownish yellow bulbs, resistant to bolting, good quality, Sweet Spanish hybrid.

Hi-Score — Late maturing, good colour, excellent neck finish, suitable for mid-season storage.

Hustler *(trial)* — Early maturing, good bulb size, mid-season storage.

Japanese Bunching — A non-bulb-forming, overwintering type, usually strong and pungent flavor.

Matador — Mid- to late-season-maturing Sweet Spanish of high quality, good resistance to bolting.

Maya — Mid-season maturity, good for onion rings, excellent skin colour. Tolerant to pink root; has some tolerance to Fusarium.

New York Early — Early variety with large, globe-shaped bulbs and yellow skin colour. Not suited for long term storage, good tolerance to pink root.

Norstar — Very early maturing, large size, high yield potential, short-term storage only.

Paragon — Very firm, high yield potential, good bulb size, excellent quality, suitable for long-term storage.

Pompei — White, earlier than Barletta, used for pearl-onion processing.

Red Wethersfield — Red-skinned, firm, medium yielding, flat, good scoring, not suitable for long storage.

Rocket — High yield, somewhat lighter colour and not quite so firm as Autumn Spice, suitable for long-term storage.

Ruby — Red-skinned, attractive, matures about 2 weeks later than Autumn Spice, short storage only.

Russet — Very high yield potential, very late maturing in Bradford area, fairly firm.

Sentinel — Very late maturing in Bradford area, very firm, excellent quality, very good yield potential, excellent for long storage.

Silver Queen — Used for pearl-onion processing.

Southport Red Globe — Red-skinned, relatively early maturing, fairly firm, medium yielding, good quality, suitable for short storage.

Southport White Globe — The main green bunching onion for early, mid, and late season.

Stuttgarter — Set-onion type used for set production, prefers sandy loam.

Sweet Sandwich — Very high yielding, top shaped, very uniform size and shape, good colour, relatively mild after some weeks in storage, suitable for medium long storage.

ONION (Continued)

Tarmagon — Early maturing, very high yield potential, large globe size, quite firm, suitable for medium long storage.

Taurus — Medium to early maturing, medium-large globe, good yielding, suitable for storage.

Trapp's No. 6 — High yield, globe shaped, good colour, firm, suitable for long-term storage.

Trapp's No. 8 — Very firm, good yielding, globe shaped, high scoring, uniform, excellent colour, long storage.

White Knight — A relatively new, long, white, green bunching type.

White Portugal — Used for green bunching, and for pickling.

SEEDING AND SPACING

Dry onions:	4 to 4.5 kg/ha
Bunching onions:	up to 7 kg/ha
Pickling onions:	35 to 45 kg/ha
Sets:	70 to 80 kg/ha

SPACING — Rows 35-43 cm apart or 15 and 60 cm apart alternately, with 30-40 plants per metre of row for dry onions and 10-12.5 cm apart in the row of Spanish transplants.

IRRIGATION

Onions have a shallow and limited root system, and should be irrigated frequently throughout the growing season. The soil moisture should not be permitted to fall below 50%. The plants should receive 2.5 cm of water a week, either as rainfall or irrigation. Irrigation may not be necessary on deep muck soils. Maintain the water table at 85 cm below the soil surface on muck soils.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOIL and on MUCK SOIL apply up to 120 kg/ha; 90 kg/ha applied preplant with one sidedressing of 30 kg N/ha when plants are 8-10 cm high (if rainfall has been above normal and soil temperatures below normal). If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — Apply 2/3 of the nitrogen before planting and the remainder sidedressed after the onions are about 15 cm tall.

MICRONUTRIENTS — COPPER deficiency occurs on acid, peat and muck soils. Onion bulbs show poor-coloured skins. Copper may be mixed with the fertilizer and applied at 14-29 kg copper/ha on new muck. Subsequent applications may be made every 2 or 3 years at about 1/3 the rate recommended for new muck.

MANGANESE deficiency shows up as a yellowing between the leaf veins. Foliar applications of manganese sulfate are recommended, starting when the plants are about 15 cm tall with 1.5-2.75 kg manganese/ha in 300 L water and repeated in 4 to 5 sprays 10 days apart. Use the low rate on small plants, increasing the rate as the season progresses. Soil application is not recommended for manganese because of the large amounts required.

MOLYBDENUM deficiency may occur when onions are grown on moderately acid to strongly acid muck soils. A seed treatment has proven beneficial. The treatment is accomplished by dissolving 15 grams of sodium molybdate in 45 mL of water. Spray this solution from an atomizer bottle on 2.3 kg seed spread thinly on a plastic sheet. Do not use excessive water as this can cause the chemical to penetrate the seed embryo and cause injury. Mix the seed thoroughly and let dry.

Spraying plants with sodium molybdate at rates supplying 60 g of molybdenum in 300 L of water will also help to avoid deficiency symptoms.

ZINC deficiency in onions shows up as a stunting and marked twisting and bending of yellow striped foliage. It occurs mainly with shallow muck soils or where the calcareous subsoils are mixed with the muck during a tile-drainage operation.

If zinc deficiency is a problem, spray the foliage with zinc sulfate at rates supplying 0.6 kg zinc per 1000 L water.

DISEASE CONTROL

DAMPING-OFF AND ROOT ROT — For Spanish onion transplants, treat seed with thiram seed protectant. Use pasteurized soil or soilless mix and disinfect trays. For field-sown onions, treat seed with thiram.

DOWNY MILDEW, BOTRYTIS LEAF SPOT AND PURPLE BLOTCH — Plant sets and mother bulbs as far as possible from onions being grown from seed. These diseases develop in humid weather or when rains and heavy dews occur frequently. Begin spraying when these conditions occur after early June in southwestern Ontario and after mid-June in the Bradford area. Then spray every 7 to 10 days with one of the following fungicides; a spreader-sticker may be required if recommended by the manufacturer.

Note: Botrytis leaf blight and downy mildew are monitored in the Bradford, and Thedford-Grand Bend marsh areas. Consult your local Pest Management Advisor for up-to-date information on disease development and timing of sprays.

1. zineb
   (i) Zineb 80 W 2.25-3.25 kg (14 days)
2. maneb
   (i) Maneb 80 W 2.25 kg (14 days)
3. mancozeb
   (i) Dithane M-45 2.25-3.25 kg (14 days)
   (ii) Dithane DG 2.25-3.25 kg (14 days)
   (iii) Manzate 200 2.25-3.25 kg (14 days)
4. anilazine
   (i) Dyrene 50 WP 2.25 kg (7 days)
5. iprodione
   (i) Rovral 0.75 kg (15 days) (when tank-mixed with label rates of maneb or mancozeb)

   Note: Rovral when tank-mixed will control Botrytis, leaf blight and downy mildew when applied on a preventative basis. This tank-mix combination will help reduce the chance of resistance to iprodione.

SMUT — Use one of:

1. Treat seed with carbathiin + thiram (PRO-GRO) 60 grams to 2.3 kg of seed. Thorough mixing of PRO-GRO with the sticker and the seed is essential for good control. Mix until no uncoated seeds can be found. Read label directions. See Onion Maggot.

ONION (Continued)

2. 37% formaldehyde — Add 1.25 L to 100 L of water and apply the diluted formaldehyde, while seeding, at 1000 L per hectare (rows 40 cm apart), or 4.5 L to 100 metres of row.
3. Steam soil for growing Spanish onion transplants.

BOTRYTIS NECK ROT AND SMUDGE — Be certain onions are mature before harvesting. Cure and dry onions properly. Artificial heat may be beneficial. Store under cool, dry conditions. White and Spanish-type onions are more susceptible to these diseases.

WHITE ROT — This disease is present in Holland, Thedford, Grand Bend and Point Pelee marshes. The fungus survives as sclerotia in the soil for long periods. The hosts are within the onion family: onion, shallot, leek, garlic. Long-term rotation with carrots, lettuce, potatoes or other crops not related to the onion family is recommended.

Sanitation is extremely important in preventing the spread of this disease. Wash down machinery after it has been used in an infested field. Avoid cultivation practices that can spread contaminated soil from one area to the rest of the field. Dispose of cull onions in a sanitary landfill or bury away from areas of onion production. Pallet boxes that have been used to hold contaminated soil or diseased onions may also be a source of disease. Botran may be helpful for control in the field. Follow manufacturer's directions. Flooding the field for 3 weeks in the fall or spring has been effective in reducing the overwintering sclerotia of the fungus.

BACTERIAL DISEASES — There are at least three different diseases of onions caused by bacteria; these are Soft Rot, Slippery Skin, and Sour Skin. The bacteria which cause Slippery Skin and Sour Skin can enter the onion through wounds on the leaves, and when heavy irrigation or rainfall results in water standing in the leaf axils and neck. Any of these bacteria can enter the bulb when the leaves wither after windrowing or through injuries that occur at harvest. Soft rot often occurs when bulbs are damaged by the onion maggot or by other bulb diseases. To reduce bacterial diseases, control the onion maggot, do not over-irrigate and avoid damaging the onions at harvest. Let the onions mature properly before harvest, then cure and dry them rapidly.

NEMATODES — **See page 32.**

INSECT CONTROL

ONION MAGGOT

1. **Dry onions grown from seed** — Apply soil treatment as in (a) **and** spray for onion maggot flies as in (b).
   a. **Furrow granular treatment:** Apply granular formulation in furrow with seed. Amounts given are for one hectare. Growers should adjust the dosage if row spacing or planting methods differ.

   Apply one of:

   1. chlorpyrifos
      Lorsban 15 G 8-16 kg (109 days), **only with carbathiin + thiram-treated seed.** Use only on dry onions and pickling onions.

      For precision seeders having a weed furrow width of 5 cm or less, use Lorsban 15 G at a rate of 64 g per 100 m of double row. Based on a standard 40 cm row spacing, this is equivalent to 16 kg Lorsban 15 G/ha. Consult the label.
   2. fonofos
      Dyfonate 10 G 23 kg (40 cm double rows). Do not use on mineral soils.
   *3. 5% ethion-7.5% thiram combination, 35-45 kg.
   *4. carbofuran
      Furadan 10 G 17 kg, **only with carbathiin + thiram-treated seed.** Do not use on pickling onions, green bunching onions, onions grown from sets, or Spanish onions from transplants.

      **Resistance to these insecticides has been observed in Ontairo muck soils.*

   OR

   b. **Sprays for onion maggot flies: proper placement of granular insecticides at the correct rate is the key to onion maggot control.** If difficulties are encountered with the granular application, sprays to kill the flies may reduce damage. Spray with one of the following materials in sufficient water to obtain good coverage as soon as flies appear. Repeat at 7- to 10-day intervals. To limit the development of resistance, the insecticide from Group A must be used alternately with insecticides from Group B.

   Group A: (Synthetic Pyrethroids)

   1. cypermethrin
      (i) Ripcord 400 EC 175 mL (3 days)
      (ii) Cymbush 250 EC 280 mL (3 days)

   Group B: (Organo-Phosphates)

   1. diazinon
      (i) Diazinon 50 WP 1.0 kg (10 days)
      (ii) Diazinon 500 EC 1.5 L (10 days)
      (iii) Basudin 500 EC 1.1 L (10 days)
   2. [3]parathion
      (i) [3]Parathion 15 WP 2.25 kg (15 days)
      (ii) [3]Parathion 960 EC 225-375 mL (15 days)
   3. naled
      (i) Dibrom 8 E 0.55 L (4 days)
   4. malathion
      (i) Malathion 500 EC 2.75 L (3 days)

   In some areas monitoring programs are carried out for the onion maggot and treatments can be timed to coincide with peak activity of the adults. This may reduce the number of spray applications. Consult your Pest Management Advisor for timing.

   Note: Permethrin 500 EC 280 mL (3 days) used for cutworm control on seedling onions will provide some control of onion flies **(see page 28).** This product also belongs in Group A, and the same considerations about alternating insecticides apply.

2. **Other Onions**
   a. Dutch Sets — Make sure insecticide is distributed evenly over the entire width of the row. Apply soil insecticide treatment as in 1(a) and sprays as in 1(b).
   b. Pickling Onions from Seed — Apply fonofos or ethion or chlorpyrifos as in 1(a) (for muck soils only) and sprays as in 1(b).

ONION (Continued)

c. Green Bunching Onions from Seed — Apply ethion as in 1(a) and sprays as in 1(b).
d. Green Bunching Onions from Sets — Apply sprays as in 1(b).
e. Spanish Onions from Transplants — Special application equipment is required to distribute insecticide uniformly within the furrow. Apply soil insecticide treatment as in 1(a) and sprays as 1(b).
f. Cooking Onions from Sets — Apply sprays as in 1(b).

Onions left in the field after harvest are a major source of overwintering onion maggot. This is especially true following early harvest of Dutch sets and pickling onions. Prevent all regrowth. Remove where possible, or plow under immediately after harvest.

THRIPS — Cypermethrin, diazinon and [3]Parathion, as recommended as a spray for onion maggot flies, also control thrips. Water volume, coverage and timing are critical.

Consult OMAF Factsheet, *Thrips On Onions And Cabbage*, Agdex 250/612.

1. cypermethrin*
   (i) Cymbush 250 EC 280 mL (3 days)
2. naled
   (i) Dibrom 8 E 0.55 L (4 days)

**Do not apply more than 3 times per season.*

[3]*Minimum period before re-entry is 7 days.*

SPROUT INHIBITION

The use of maleic hydrazide (Royal MH 60) sprays will improve the storage life and quality of onions by inhibiting sprouting in storage. Short-storage-life cultivars do not benefit from maleic hydrazide sprays. Apply at a rate of 3.75 kg in a minimum of 300 L of water/ha for ground equipment or a minimum of 100 L of water for aerial equipment. To obtain maximum benefit, spray when about 50% of the onion tops have fallen and each plant has 5-8 green leaves. This will occur about 10-14 days before harvest. Earlier application may result in spongy, hollow-necked bulbs.

PARSNIP

For more detail, **consult OMAF Factsheet, *Commercial Parsnip Production in Ontario*, Agdex 258/13.**

CULTIVARS
(Revised for 1992)

All-America	Harris Model
Andover	Hollow Crown Improved

CULTIVAR DESCRIPTIONS

Andover — Gradually tapered root, superior storing ability, vigorous tops, resistant to Phoma canker.

All-American — Early cultivar with smooth wedge-shaped white roots, tall, strong tops.

Harris Model — Smooth, slim, tapered root, good appearance.

Hollow Crown Improved — Wedge-shaped, smooth white roots with fine texture, short tops.

SEEDING AND SPACING

Parsnips are a long-season crop (100 to 130 days to maturity), so the seed must be sown as early as possible. Always use seed produced the preceding year. The seed is slow to germinate, especially in dry, cool soils. Poor stands occur if the soil surface becomes baked or crusted before the seedlings emerge.

RATE — 3 to 5.5 kg per hectare.

DEPTH — 6 to 20 mm.

ROW SPACING — 45 to 75 cm depending on machinery used in cultivation.

THINNING — Thin seedlings 3-6 cm in the row. On muck soils seeders should be adjusted to ensure a stand of 16 to 33 plants per metre of row.

SOIL

Parsnips require deep, loose, fertile soils, preferably a well-drained, warm sandy loam. Well-drained muck soils are also suitable. The desired pH is about 6.5.

FERTILIZER

Fertilizer requirements are the same as for carrots.

DISEASE CONTROL

ITERSONILIA CANKER AND LEAF SPOT — High ridging to cover the shoulder of the roots is helpful. The cultivar Andover has resistance to itersonilia and phoma canker.

PHOMA CANKER AND LEAF SPOT — Andover, Hollow Crown Improved and All-America are tolerant cultivars. They can be grown instead of Model, the most susceptible cultivar,

PARSNIP (Continued)

and harvested before maximum root and shoulder development. Rotate with other crops. Removal of crop refuse will help to control the disease.

Handling diseased or healthy plants using gloves will prevent the development of severe skin rashes for some people.

For more detail, **consult OMAF Factsheet, *Phoma Canker of Parsnip*, Agdex 258/635.**

ROOT-KNOT NEMATODES — **See page 32.**

INSECT CONTROL

CARROT RUST FLY — See CARROT-INSECT CONTROL

Spray when recommended with one of:

1. diazinon
   (i) Diazinon 500 EC 1.1 L (10 days)
   (ii) Diazinon 50 W 1.1 kg (10 days)
   (iii) Basudin 500 EC 1.1 L (10 days)

PEA

CULTIVARS
(Not revised for 1992)

MARKET	PROCESSING
Sugar Snap types	As recommended
Green Arrow	by processors
Litle Marvel	
Alderman (Tall Telephone)	
Progress types	
Lincoln (Homesteader)	

SEEDING

DATE — As early as possible. Sowing of acreage for processing is now scheduled on the basis of accumulated heat units.

RATE — 250 to 400 kg/ha depending on seed size and percent germination.

DEPTH — During April and early May soil moisture is usually adequate and seed can be sown 2.5 to 4 cm deep. For later seedings a depth of 4 to 5 cm may be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — 15 kg N/ha is recommended at seeding where phosphate and potash are required. If no phosphate and potash are required the nitrogen may be omitted.

APPLICATION — Fertilizers should be broadcast and worked in before seeding. Do not drill fertilizer with the seed.

DISEASE CONTROL

ROOT ROT, WILT AND NEAR-WILT — Follow a 4-year rotation and other good management practices such as:

1. Select and plant only in well-drained fields.
2. Minimize soil compaction.
3. Work fields immediately after harvest.
4. Plant a green-manure crop such as sorghum, Sudan grass, or fall rye.

INSECT CONTROL

SEED MAGGOTS, WIREWORMS AND SEED DECAY — Treat seed with diazinon, lindane, and a fungicide. **See Chemical Seed Treatment, page 30.**

PEA APHID — This aphid is usually more abundant when peas are grown adjacent to clover or alfalfa. Various methods of sampling are carried out by fieldmen to tell whether sprays are required.

1. dimethoate
   (i) Cygon 480 E 425 mL (3 days). Do not feed or graze vines within 21 days of last application.
2. malathion
   (i) Malathion 25 WP 4.5 kg (3 days)
   (ii) Malathion 500 EC 1.75 L (3 days)
3. [3]parathion
   (i) [3]Parathion 960 EC 225-450 mL (10 days). Do not feed or graze within 15 days of last application.
4. pirimicarb
   (i) Pirimor 50 W 150-275 g (6 days). (Do not apply Pirimor if peas are to be exported to the U.S.A.)
5. naled
   (i) Dibrom 8 E 1.1 L (4 days) (processing only)
6. endosulfan
   (i) Thionex 50 WP 1.1-1.75 kg (7 days)

PEA WEEVIL — Infested seed should be fumigated. Use a commercial grain fumigant.

1. endosulfan
   (i) Thionex 50 WP 1.1-1.75 (2 days)

[3]*Minimum period before re-entry is 7 days.*

For more details, consult **OMAF Factsheet, *Peas for Processing*, Agdex 255/20.**

PEPPER

CULTIVARS
(Revised for 1992)

Cultivars listed in approximate order of maturity.

(1) SWEET PEPPERS:

(A) RED:*
- Super Set
- North Star
- Lady Bell
- Merlin *(trial)*
- Bell Captain
- Melody

(B) GREEN:
- North Star
- Lady Bell
- Belle Star
- Merlin *(trial)*
- Bell Tower
- Bell Captain
- Mayata
- Domino *(trial)*
- Midway

(2) ELONGATED SWEET PEPPERS:
- Sweet Hungarian (Yellow Banana)
- Laparie
- Super Shepherd

(3) HOT PEPPERS:
- Crimson Hot
- Hungarian Wax
- Romanian Wax
- Diablo Grande
- Surefire

**All peppers will turn from green to red when ripe.*

CULTIVAR DESCRIPTIONS

Bell Captain — Midseason, large elongated 3-4 lobed fruit, uniform red at maturity.

Belle Star — Early midseason, high yielding, blocky, thick-walled fruit, very uniform fruit size and shape, high yield potential.

Crimson Hot — Hot pickling/fresh Chili type; 14 cm long and 3.5-4.0 cm at the shoulder, fruit turns dark red and sits high on a fairly large plant.

Diablo Grande — Large tapered fruit, light green, ripens to red, larger than most other hot peppers.

Domino *(trial)* — Early, medium to large blocky fruit, high yielder.

Hungarian Wax — Hot pickling type, prolific, 12-15 cm long yellow fruits, turn crimson when mature.

Lady Bell — Early, medium sized blocky fruit, may have a problem with blossom-end-rot on some soils.

Laparie — Elongated, pointed fruit, Italian-type pepper, fruit approximately 20 cm long, high yielder.

Mayata — Late season maturity, elongated, 3- to 4-lobed bell, heavy fruit, high yield potential.

Merlin *(trial)* — Midseason, good fruit size and yield potential, blocky fruit, ripens to a uniform red colour.

Melody — Long semi-tapered, 2-3 lobed bell, attractive red colour, consistent yielder.

Midway — Mid-late season, large smooth attractive green fruits, large plant.

North Star — Early, medium sized blocky fruit, good yield potential.

Romanian Wax — Hot pickling type with upright, semi-long, pointed fruits.

Sweet Hungarian — Fruit are approximately 4 cm wide and 15 cm long, tapered, yellow ripening to red.

Super Set — Very early, medium sized, three-lobed fruit, turns uniform red earlier then most other peppers.

Super Shepherd — Early, productive, with 15-18 cm pointed pendant fruit with thick walls.

Surefire — Very pungent, long, tapered/pointed fruit, good foliage cover.

SEED TREATMENT

Sow hot-water-treated seed **(see page 30).** Before sowing, dust seed with thiram seed protectant.

SEEDING AND SPACING

Two hundred grams of seed should produce enough plants for a hectare.

Rows 90 to 120 cm apart. Plants 35 to 45 cm apart.

TRANSPLANTS

Pepper crops may be established from southern bare-root or greenhouse grown transplants. Experience has shown that greenhouse-grown transplants are more reliable and have less potential for severe disease problems. Greenhouse-grown seedlings should be grown in plug-type containers to reduce the amount of root damage during transplanting. Larger cell sizes such as 72 or 98 cell trays promote higher early yields, and are recommended for early fresh market crops. Otherwise, for main season fresh market and processing crops, the 200 cell tray is recommended. Smaller cell sizes may be used but these require more management, such as watering. **Consult OMAF Factsheet, *Growing Vegetable Transplants In Plug Trays*, Agdex 250/22.**

PLANT POPULATION

A standard planting arrangement for pepper crops is single rows with 1.0 m between rows and 45 cm between plants within the row (9,000 plants/ac). Some early, small plant type varieties may be planted at 1 m between rows and 30 cm between plants. Alternatively, peppers may be planted on twin rows at 1.5 m centers, with 45 cm between the twin rows, and 45 cm between plants within the row.

PLASTICULTURE

Research has demonstrated that the use of plasticulture (plastic mulches, row covers and drip irrigation) can improve production of peppers. Since these practices are relatively expensive, they are likely more suitable for fresh market pepper production. Black plastic mulch is recommended for peppers because it warms the soil, retains moisture and controls weed growth. (Twin row culture is recommended on plastic mulch).

Earlier production of peppers may be achieved by planting 10-14 days earlier than normal and covering the crop with a white plastic row cover. This cover should be opened for ventilation when the temperature inside reaches 35°C or higher. The cover should be removed in early June or whenever conditions are favourable for good growth.

PEPPER (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 70 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19)**

APPLICATION — Broadcast 35 kg N/ha and all of the phosphate and potash required before planting and work in. The remainder of the N should be side-dressed after first fruit set, if required.

STARTER SOLUTION — At transplanting apply a starter solution high in phosphorus such as 1 L of 10-34-0 per 100 L of water or 1 L of 6-24-6 per 75 L of water. Under high temperature conditions or in dry sandy soils reduce the amount of fertilizer by one-half but continue to use the same volume of water. This will reduce the risk of crop injury under these growing conditions.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment and sections on Hot-Water Seed Treatment and Damping-off of Seedlings **(page 30).** Because unsterilized soil and mixes containing peat moss, pit sand and soil often give rise to damping-off, sow and transplant only in a sterilized medium. Drench flats at time of first watering with captan 50 WP or 80 WP (see label). Spray when first true leaves develop, with captan 50 WP 2.25 kg and repeat every 7 to 10 days. Apply sufficient spray to wet plants and run down stems.

BACTERIAL LEAF SPOT — See In The Seedbed in the disease control section of Tomato, **page 78.** It is not possible to completely control this disease with chemical sprays. A reduction in the number of lesions may be achieved through the application of one of the copper bactericides tank-mixed with mancozeb 80 WP at 2.25 kg product per hectare. Do not delay spraying these compounds once mixed in the tank. In periods of extended wet weather, a control using copper materials may not be satisfactory.

VIRUS — Control aphids (see Insect Control). Some cultivars have considerable resistance to some viruses. (Consult seed catalogue.)

VERTICILLIUM WILT — Grow seedlings in sterilized soil. Wilt may be serious following peppers, tomatoes, eggplant, potatoes, strawberries and raspberries.

NEMATODES — **See page 32.**

INSECT CONTROL

APHIDS — Spray with one of the following which are listed in order of best control:

1. pirimicarb
   (i) Pirimor 50 W 275-550 g (3 days)
2. dimethoate
   (i) Cygon 480 E 0.7-1.0 L (3 days)
3. diazinon
   (i) Diazinon 50 WP 1 kg (5 days)
4. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)

TARNISHED PLANT BUGS — Dimethoate, as recommended for aphids, will give some control of tarnished plant bugs.

CORN BORER — Peppers are susceptible to corn borer attack when the fruit are the size of walnuts and must be protected from then until harvest if corn borers are present. A European corn borer monitoring service now provides information on adult flight patterns throughout Ontario. Consult Agriphone for details. For chemical control, thorough distribution of spray material is required. If a hydraulic boom sprayer is used, solid- or hollow-cone nozzles on drop pipes have improved coverage. Add an insecticide for aphids when needed. Carbofuran also suppresses aphids.

Use one of:

1. deltamethrin
   (i) Decis 2.5 EC 500-600 mL (3 days)
2. permethrin
   (i) Ambush 500 EC 140 mL (1 day)
3. [2]carbofuran
   (i) [2]Furadan 480 F 1.1 L (3 days). Do not use more than 6 applications per season.
4. carbaryl*
   (i) Sevin XLR Plus 2.5-5.25 L (2 days)

**In areas where corn borer has been a problem, spray sprays every four days.*

PEPPER MAGGOT — In areas where required apply 4 sprays at 7-day intervals starting the last week of June or first week of July using one of:

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 1.5 L (2 days)
2. malathion
   (i) Malathion 25 WP 5.5 kg (3 days)
3. dimethoate
   (i) Cygon 480 E 0.7-1.0 L (3 days)

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[2]*Minimum period before re-entry is 48 hours.*

POTATO

For more details **consult OMAF Publication 534, *Potato Production in Ontario.*** For detailed information on cultivars, consult the OMAF Management Profile Factsheets. Seed availability of new or specialty cultivars can often be limited. To ensure a supply of seed, growers should contract with their seed growers. For information on contracting and seed availability lists, contact the Ontario Seed Potato Growers Association at P.O. Box 370, Alliston, Ontario, L0M 1A0.

CULTIVAR DESCRIPTIONS

Listed in order of maturity
(See Table Below For Recommended Market Use)

Jemseg — Very early; smooth, blocky tubers; good yield; early-season boiler and chips out of the field; tubers oversize very quickly; tubers allowed to oversize usually develop hollow heart; not a storage potato; immune to virus X; resistant to viruses Y and S; moderately resistant to common scab; susceptible to leafroll, Verticillium wilt and Fusarium storage rot; cut seed should be held and suberized before planting. Due to poor eye distribution, large seed tubers (over 250 g) are best cut by hand to avoid poor stands from blind seeds pieces.

Eramosa — Very early, smooth round flattish tubers; sets and sizes evenly; vines are very determinate, sets very few flowers; tuber skin is attractive; moderately susceptible to scab and virus Y; not prone to oversizing and has some field tolerance to leaf roll; seed should be well-warmed or chitted prior to planting. Cut seed should be held to suberize at least one week before planting.

Superior — Early; fairly smooth; high yield; good for tablestock and as a mid-summer chipper; stress, e.g. drought or disease, reduces yields substantially; resistant to scab but very susceptible to Verticillium wilt at maturity; may be subject to seed-piece breakdown in a wet spring.

Conestoga — Early; blocky, medium smooth; very vigorous early growth; yield comparable to Superior; good boiler, chips well out of the field; moderately resistant to leafroll, early blight and common scab; moderately susceptible to mild and rugose mosaic. A slight bitterness in the tuber flesh may be observed if this variety is harvested either very immature or when grown under very stressful conditions.

Redgold — Medium early; round rose-skinned tubers with deep yellow flesh; sets heavily and may fail to size well and has only average dry matter but good flavour. Will sprout readily after harvest where most cultivars require several weeks to break dormancy. Susceptible to ozone injury. A specialty potato for the '**technicolour** trade'.

Yukon Gold — Medium-early; tubers round, smooth; yellow-fleshed with pink eyes; good flavour; medium-high yield; good boiling, baking and French-fry quality; chips out of the field; upright plants; moderately susceptible to common and pitted scab and virus Y and ozone; resistant to mild mosaic and leafroll; excellent keeping potato; often sold in stores by name; cut seed is best held to suberize before planting to avoid poor stands.

Atlantic — Medium-early; round, smooth; medium-netted tubers; high yield and dry matter, vigorous plant; chips excellent out of the field; but chip colour is variable out of 10°C storage; tolerant to Verticillium wilt; resistant to virus X, pink eye, but susceptible to internal heat necrosis in hot soils, Fusarium dry rot in storage and hollow heart, white knot and post emergent applications of metribuzin. Moderately susceptible to metribuzin applied pre-emergent on low organic-matter soils; susceptible to harvest bruising and pressure bruising in storage.

Cherokee — Medium early, medium yield potential and good keeper in storage. Tubers have one of the whitest skins of any variety and are very attractive for the washed trade. Misshapen tubers may be a problem under adverse weather conditions; resistant to common scab and some races of late blight; susceptible to verticillium wilt and leaf roll.

Keswick — Midseason; light green foliage; fairly smooth under close spacing; good cooking quality; makes good mid-season French fries; resistant to scab, late blight and hollow heart; susceptible to virus Y, Fusarium dry rot and mosaic; better adapted to Northern Ontario.

Norchip — Mid-season; roundish, white-skinned, slightly rough tubers; sets a lot of tubers so needs 30 to 33 cm spacing for better sizing; medium yield; responds to higher nitrogen, scheduled irrigation and strong soil with good tilth; good chipper out of 10°C storage; resistant to scab and hollow heart; susceptible to early and late blight, Verticillium wilt or any setback in growth.

Saginaw Gold — Maincrop with attractive skin and light yellow flesh; good yield, good flavour and nice vine; bred at Michigan State University and entirely developed in Ontario . . . the first "Free Trade" potato! Chips very well out of 10°C storage and has field resistance to disease pick-up; only medium scab resistance. Susceptible to internal blackspot and early (within a week) post-harvest pythium leak.

Monona — Maincrop; roundish, white-skinned, medium-eyed tubers, medium to good yield; sizes better than Norchip but is low in dry matter; chiefly used as a long-term 10°C storage chipper; not recommended for tablestock; resistant to virus Y, A, and Verticillium wilt; moderately susceptible to hollow heart and blackleg; requires good storage ventilation.

Chieftain — Maincrop; fairly smooth, round; red skin, very white-fleshed tubers, sets heavily; high yield; low dry matter; good boiler but doesn't process; susceptible to Verticillium wilt, blackleg, virus X and Y; moderately resistant to common scab, Rhizoctonia, stem-end browning and late blight; skin must be mature to avoid feathering at harvest; susceptible to shattering under wet soil conditions coupled with wide differences in air and ground temperature; more susceptible to heat necrosis than Rideau.

Kennebec — Maincrop; heavy vigorous plant; tubers thin-skinned, set light and size well; plant under close spacing 20-25 cm; very high yield and medium dry matter and good flavour; do not use more than 130 kg of nitrogen; chips but does not store reliably in 10°C storage; fair French-fry quality; tubers green rapidly under light; resistant to virus A and Y and visual

POTATO (Continued)

field mosaic, foliage late blight, and drought; very susceptible to Verticillium wilt and pink eye; moderately susceptible to common scab, late blight tuber-rot and leafroll.

Shepody — Maincrop; large oblong, smooth-eyed tuber; good to high yield; excellent boiler, baker and French-frier, good prepeeler; does not chip out of storage; medium dry matter; moderate resistance to early blight, Fusarium dry rot and Rhizoctonia; moderately susceptible to common scab, Verticillium wilt, late blight and virus Y and S; very susceptible to mild mosaic and post-emergent applications of the herbicide metribuzin. Pre-emergent applications of metribuzin on low organic-matter soils may also cause damage; good resistance to tuber shattering.

Rideau — Late maincrop; high yielding slightly oblong, large round tubers; very shallow-eyed with a bright red skin and very white flesh; persistent vine; low to medium dry matter; good flavour; good boiler, does not process; resistant to Verticillium wilt, moderately resistant to scab and mosaic; susceptible to Rhizoctonia. Susceptible to Fusarium and Phoma storage rots if mechanically injured at harvest. This is a problem variety to store.

Sebago — Late; good cooking quality and flavour; yield variable; round shallow-eyed, white-skinned tuber; moderately resistant to Virus A, Y, X, common scab and blight; sprouts early; very susceptible to blackleg.

Main End Uses For Potatoes Grown In Ontario.

TABLESTOCK	PROCESSING
Superior (main early)	Norchip (main storage chipper)
Shepody (main storage)	Atlantic (main field chipper)
Kennebec (storage)	Monona (long storage chipper)
Chieftain (main red)	Superior (field chip — prepeel)
Sebago (storage)	Shepody (prepeel)
Yukon Gold (yellow flesh)	Kennebec (prepeel)
Jemseg (earliest)	
Conestoga (early, table)	
NEW OR SPECIALTY	
Jemseg (very early)	Red Gold (red skin yellow flesh)
Eramosa (very early)	Saginaw Gold (light yellow flesh)
Rideau (red skin)	Keswick (fresh dry for North)

SANITATION

The storage and all potato equipment including cutting knives and containers should be completely cleaned before using. Clean out and thoroughly scrub with detergent all machinery, equipment, walls, floors, etc., and then use a quaternary ammonium compound labelled for bacterial ring rot control as a disinfectant. All cull potatoes should be spread out on the field to freeze, or destroy all potato foliage on cull piles early in the season with a suitable vine killer.

SEED HANDLING AND TREATMENT

Plant Elite or Foundation Class seed to reduce leafroll, mosaic and bacterial diseases.

Inspect seed on arrival and during cutting. Discard tubers and seed pieces showing rot.

Where practical, warm seed potatoes before cutting 18 to 20°C for two weeks in good light. Cut seed not being planted immediately should be given special attention to ensure healing and suberization by:

(a) Forced-air circulation through the shallow pile
(b) Temperatures of 10 to 15°C
(c) High relative humidity in the air of 90 to 95%
(d) Maintain these conditions for 3 to 4 days
(e) After this, temperature may be lowered but maintain humidity and run fans intermittently.

Cut seed stored in boxes or bags should get the same conditions and be piled to allow good air movement around each container.

Never allow cut seed to stand in the hot sun or in drying wind. This causes minute cracks in the skin that allow bacteria and fungi to get established.

Do not plant in hot dry soil or in cold wet soil.

Do not plant potatoes immediately after plowing down a heavy stand of rye.

Chemical Treatment — Seed-piece treatments with a commercial dust may be beneficial, particularly in areas where maggots are a serious pest. The following commercial dusts may be used (rates are for 50 kg of cut seed):

1. metiram-diazinon dust at 450-700 g
2. captan 7%-diazinon 0.1% dust at 450 g
3. thiophanate-methyl (Easout) 250 g
4. metiram 7 dust (Polyram) 500-750 g
5. metiram 16 dust (Polyram) 225-325 g

SOIL

A soil pH of 6 to 7 is desirable for optimum growth of potatoes. However, lower pH values down to 5.0 may provide better control of scab. Apply limestone to rotation crops where possible, and in the fall if potatoes follow potatoes.

Soil organic matter can be maintained by use of well-decomposed barnyard manure, grass or legume sod crops, or cover crops. A thick cover crop seeded after early potatoes will reduce soil blowing and fertilizer leaching. Manure should be fall-applied and incorporated.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply 130 kg N/ha on MINERAL SOILS for MAIN CROP potatoes and 70 kg N/ha for early potatoes. Apply up to 60 kg N/ha on MUCK SOILS. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — On MINERAL SOILS testing medium or low for phosphate, some or all of the phosphate fertilizer should be placed in bands 2.5 cm below and 6 cm to each side of the seed piece at planting time. On MUCK SOILS or on MINERAL SOILS testing high for phosphate, placement is less critical and fertilizer may be broadcast.

If the total N plus K_2O applied is over 360 kg/ha at least a portion should be broadcast before planting to avoid too concentrated a band near the seed piece and potato roots. Broadcasting or side-dressing N after potatoes are 20 cm high is not generally recommended because it may delay maturity.

POTATO (Continued)

PLANT ANALYSIS — Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately. For potatoes the fourth leaf, including stem, for the growing tip at early bloom is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant-analysis results when the samples are not taken at early bloom. A soil sample should be taken from the same area and at the same time as a plant sample. For more information on plant analysis see page 19.

INTERPRETATION OF PLANT ANALYSIS FOR POTATOES

Nutrient	Units	Critical Concentration*	Maximum Normal Concentration**
Nitrogen	%	2.50	3.50
Phosphorus	%	0.15	0.50
Potassium	%	1.20	2.50
Calcium	%	—	1.50
Magnesium	%	0.10	0.60
Sulphur	%	0.14	—
Boron	ppm (ug/g)	2	25
Copper	ppm	2	25
Manganese	ppm	15	150
Zinc	ppm	14	70

Values apply to the fourth leaf, including stem, from the growing tip at early bloom.

**Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

***Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

DISEASE CONTROL

Practise a suitable crop rotation to prevent build-up in the soil of organisms causing blackleg, wilt, Rhizoctonia, common scab, early blight and silver scurf.

SEED-PIECE DECAY — See Seed Handling and Treatment.

COMMON SCAB — Choose a resistant cultivar suitable for the area and the market. See Soil Reaction, and Seed Handling and Treatment. Where irrigation is available, it is important to maintain high soil moisture for about 4 weeks after tuber setting begins where scab has been a problem.

POWDERY SCAB — Only a problem in Northern Ontario. Plant Elite or Foundation seed. Plant in warm, well-drained soil. Do not plant in fields in which powdery scab has occurred in the last four years.

RHIZOCTONIA — Avoid land known to be heavily infested. Rotate the crop, e.g. spring barley on mineral soil, or onions on muck soils. To reduce attacks on eyes and sprouts, plant to a depth of 8 to 10 cm without hilling. See Seed Handling and Treatment.

VERTICILLIUM WILT — On land where this disease was severe allow at least a 3-year rotation with a cereal, corn or other suitable non-Verticillium-susceptible crop. To be effective, a high degree of weed control is absolutely essential. Test soils for Verticillium levels before planting. See nematodes page 32.

BACTERIAL RING ROT — See section on Sanitation. Do not save any of your own potatoes for seed.

BLACKLEG — (a bacterial disease) — See Seed Handling and Treatment and section on Sanitation. Planting whole seed may help reduce loss.

SPINDLE TUBER — Use Elite or Foundation class seed.

LEAF-ROLL VIRUS AND NET NECROSIS — Use Elite or Foundation class seed. Because leaf roll is spread by aphids, the control of this insect is important, especially with the cultivar Russet Burbank, to avoid net necrosis caused by current-season infection.

EARLY BLIGHT — Early blight is particularly damaging to the cultivars Norchip and Superior. Begin your fungicide spray program early to that lower plant foliage is well covered. This is where blight infections first begin. Conditions **favourable** for disease development are combinations of temperatures between 17-24°C and 12 hours of leaf wetness throughout the plant canopy. In addition, stress conditions such as drought, insect damage, air pollution, rapid growth at tuber sizing, increases the foliar susceptibility to early blight. Under these conditions spray intervals should be shortened to 7 days.

LATE BLIGHT — This fungus overwinters in infected tubers — be they seed tubers or culls, and initially develops inside the new foliage grown from infected tubers. Temperatures of 10-20°C coupled with foliar wetness (1-3 days) could cause sporulation of the fungus from the stomates of infected plants which could further blow to infect healthy wet foliage. A small pool of infected plants can spread to a whole field if uncontrolled.

Therefore, it is wise to: bury all cull piles; plant Elite or Foundation class seed; use a protective fungicide program (items 1-4 below); use a corrective or preventative program containing, e.g. metalaxyl products; use a good hill; and thoroughly kill vines 2-3 weeks before harvest ... should reduce infection of tubers.

EARLY AND LATE BLIGHT CONTROL

Use one of the following:

1. chlorothalanil
   (i) Bravo 500 1.75-2.25 L (1 day)
2. mancozeb
   (i) Dithane M-45 2.25 kg (14 days)
   (ii) Manzate 200 2.25 kg (14 days)
3. maneb
   (i) Dithane M22 2.25 kg (14 days)
   (ii) Maneb 80 WP 2.25 kg (14 days)
4. metiram
   (i) Polyram DF 2.25 kg (14 days)
5. metalaxyl/MZ
   (i) Ridomil 72 W 2.5 kg (1 day). Use at 10 to 14 day intervals. For late blight only.
6. anilazine
   (i) Dyrene 50 WP 2-3 kg (3 days)

NEMATODES — See page 32.

INSECT CONTROL

SOIL INSECTS — Cutworms, Wireworms and White Grubs — See pages 28 and 33.

POTATO (Continued)

FOLIAGE INSECTS — Tarnished Plant Bugs, Leafhoppers, Flea Beetles, Colorado Potato Beetles

a. ***Cultural Control.*** Due to widespread development of insecticide resistance, Colorado potato beetle has become the most serious insect pest of potato foliage. Growers can reduce beetle populations by *rotating* potato production from field to field. In addition, *vine killing* as soon as possible in the fall and *working down* cull potatoes remaining in the field after harvest will remove preferred food supplies from the field — increasing winter mortality of late-season beetles.

b. ***Soil Treatment.*** **For main crop and seed potatoes only. Do not dig potatoes within 90 days of application.**

It is possible to control Colorado potato beetles, leafhoppers, flea beetles and aphids early in the season with one of the following granular materials applied in the furrow at planting time.

These chemicals are extremely toxic. Carefully follow all precautions given by the manufacturer.

1. phorate
   (i) Thimet 15 G, 14.5-22.4 kg (90 days). Use the higher rate on heavy silt or clay loam soils. **Do not use on muck soils.**
2. carbofuran
   (i) Furadan 10 G, 32.5 kg (90 days). **Does not control aphids or Colorado potato beetles.**
3. disulfoton
   (i) Di-Syston 15 G, 15-22.5 kg or 720 LC 2.75-4.75 L (90 days). **Does not control Colorado potato beetle.** Do not allow the 720 LC formulation to come in contact with the seed piece. For both formulations use the high rate on clay and muck soils.

Note: To reduce the possibility of ground water contamination and slow the development of potato beetle resistance, alternate soil insecticides each year.

For **late-season** control, apply an appropriate foliar insecticide. If soil was treated at planting time with disulfoton or phorate, choose an insecticide from Group B or C; if it was treated with carbofuran, choose from Group A or B.

c. ***Spray Program.*** Regular field scouting provides accurate information on development and location of problem insect populations — increasing effectiveness of foliar sprays.

For example, young Colorado potato beetle larvae are much easier to control than adult beetles. Border sprays may provide adequate protection of new potato fields from migrating Colorado potato beetles.

Before foliar spraying to control Colorado potato beetles, a Dip Test is recommended to establish the insecticide most effective for your farm. Consult your nearest Crop Advisor for assistance. Note: Many insecticides listed in Groups A, B, C and D may be less than 50% effective in several regions of Ontario.

To control insecticide-susceptible Colorado potato beetles, potato flea beetles, tarnished plant bugs or potato leafhoppers, use one of the following insecticides as listed in groups A, B, C & D.

WARNING! In a number of counties and regions, Colorado potato beetles have developed at least 10-fold resistance to a number of insecticides as follows:

GROUP A	GROUP B	GROUP C
Elgin	Essex	Brant, Elgin, Essex,
Huron	Huron	Haldimand-Norfolk,
Kent	Kent	Hamilton-Wentworth,
Lambton	Lambton	Huron, Kent, Lambton,
Prescott & Russell	Simcoe	Middlesex, Prescott & Russell, Simcoe, Waterloo

Not all populations in the listed regions will be resistant to these insecticides but growers in those regions should carefully monitor effectiveness of spray applications. Resistance levels are highest for carbofuran (Group C) and endosulfan (Group D).

Growers with resistant Colorado potato beetles should consult their local OMAF Crop Advisor and apply insecticides **only** from groups of insecticides still effective on their farms.

To slow the development of further resistance it is essential for **all** growers to alternate insecticides, choosing one from a different group each time a spray is applied. Young larvae are easier to control than adult beetles.

GROUP A (Organo-Phosphates)

1. [1]methidathion
   (i) [1]Supracide 240 EC 1.2 L (14 days)
2. [2]methamidophos
   (i) [2]Monitor 480 EC 1.75-2.25 L (14 days)
3. chlorpyrifos
   (i) Lorsban 4 E 1.0 L (7 days)
4. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (1.5 L for Colorado potato beetle) (7 days)
   (ii) [2]Azinphos-Methyl 240 EC 1.7 L (7 days)
5. phosmet
   (i) Imidan 50 WP 2.25 kg (7 days)

GROUP B (Synthetic Pyrethroids)

1. deltamethrin
   (i) Decis 2.5 EC 200-300 mL (3 days)
2. fenvalerate
   (i) Belmark 300 EC 100-150 mL (7 days)
3. permethrin
   (i) Ambush 500 EC 150-200 mL (1 day)
   (ii) Pounce 384 EC 185-250 mL (1 day)
4. cypermethrin
   (i) Ripcord 400 EC 90 mL (125 mL for tarnished plant bug) (7 days)
   (ii) Cymbush 250 EC 140 mL (200 mL for tarnished plant bug) (7 days)

GROUP C (Carbamates)

1. [2]carbofuran
   (i) [2]Furadan 480 F 1.1 L (7 days)
2. [1]oxamyl
   (i) [1]Vydate L 2.3-3.0 L (7 days)
3. carbaryl
   (i) Sevin XLR Plus Su 1.25 L (7 days)

GROUP D (Chlorinated Hydrocarbons)

1. endosulfan
   (i) Thiodan 50 WP 1.1 kg (1 day)
   (ii) Thiodan 4 EC 1.4 L (1 day)
   (iii) Endosulfan 400 EC 1.5 L (1 day)

POTATO (Continued)

GROUP E (Bacterial)

1. Bacillus thuringiensis*
   (i) M-One 7.0-9.0 L (1 day) (for small larvae only)
   (ii) Trident 10-14 L (1 day) (for small larvae only)

**For 1st and 2nd instar Colorado beetle larvae only; other stages and other insects not controlled.*

Aphids — For green peach, potato or Buckthorn aphids, apply one of the following:

1. [2]methamidophos
   (i) [2]Monitor 480 EC 1.75-2.25 L (14 days)
2. pirimicarb
   (i) Pirimor 50 W 450-550 g (3 days)
3. [2]oxydemeton-methyl
   (i) [2]Metasystox-R 240 SC 1.75-2.25 L (7 days)
4. [1]oxamyl
   (i) [1]Vydate L 3 L (7 days)
5. dimethoate
   (i) Cygon 480 E 550 mL-1.1 L (7 days)
6. fenvalerate
   (i) Belmark 300 EC 225-325 mL (7 days)
7. deltamethrin
   (i) Decis 2.5 EC 500 mL (3 days)
8. [2]azinphos-methyl
   (i) Guthion Solupak 50 WP 1.75 kg (7 days)
   (ii) Guthion 240 SC 3.5 L (7 days)

Late-Season Cutworms — have caused both tuber and foliage damage. Control of these cutworms can only be obtained when they are active above the soil surface prior to tuber migration and feeding. Thorough penetration of dense foliage is required for optimum control. Consult your local Horticultural Crop Advisor or Pest Management Advisor regarding insect adult flights to aid in spray-timing decisions.

Apply one of:

1. permethrin
   (i) Ambush 500 EC 140 mL (1 day)
2. chlorpyrifos
   (i) Lorsban 4 E 1.0 L (7 days)
3. cypermethrin
   (i) Ripcord 400 EC 175 mL (7 days)

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[1]*Minimum period before re-entry is 24 hours.*
[2]*Minimum period before re-entry is 48 hours.*

SPROUT INHIBITION

After completion of a rest period, potatoes sprout readily. Potatoes treated with chemical sprout inhibitors can be stored at 10°C or higher without sprouting.

FIELD-APPLIED. Maleic hydrazide is a plant growth regulator, applied as a single application in the field to control sprouting of potatoes in storage.

It should be applied in a manner that insures complete and uniform coverage. Timing is important. Recent research has shown that too early an application, on some cultivars, such as Norchip, may result in reduced potato size and phytotoxicity.

Consult manufacturer's recommendations and your local OMAF Crop Advisor for more detailed information on both rates and timing. Time of application may occur as early as 2-3 weeks past full bloom. Only apply to plants that are still green and free from insects, disease and other damage.

Once in storage, tubers treated with maleic hydrazide will *not* affect seed potatoes stored in the same storage, or those stored in crates formerly used for the storage of maleic hydrazide-treated tubers.

STORAGE-APPLIED. CIPC is another chemical which is widely used for sprout inhibition.

Apply it in storage as a dip, spray or aerosol just before sprouting starts. Potato tubers may be treated with this chemical before packaging for market. Do not apply CIPC at harvest time.

Do not use either of these treatments on potatoes grown for seed. Do not store seed potatoes in the same storage with CIPC-treated tubers, or in crates which were in the storage when CIPC was applied.

VINE KILLING

Vine killing is especially important to growers of Certified seed as an early kill controls tuber size and reduces the spread of virus diseases by aphids.

Chemical vine killers are not recommended for early potatoes because they limit the yield, size and dry-matter content without reducing skinning.

Use diquat according to manufacturer's directions, which will vary according to plant vigour and the type of growing season. **Ensure that no drift occurs from any of these materials to adjacent crops** because the residue of these compounds on other crops may result in their seizure.

Allow at least 14 to 21 days between vine-killing and harvesting so that skins of the tubers may set. For proper rate and time between application and harvest, consult labels for individual chemicals. If late blight is present, a quick kill is desirable; this may cause a slight darkening at the stem end of the tubers but will not change the specific gravity.

The use of roto-beaters is not recommended except where dead vines or weeds are a hindrance to the digger.

STORAGE

Store seed tubers separately from table-stock potatoes, in a clean storage. Do not store seed potatoes in the same storage with CIPC-treated tubers.

Healing of cuts and bruises is most rapid at a tuber temperature of 15 to 21°C. It is desirable to provide this temperature for two to three weeks at the beginning of the storage period. After this the temperature should be lowered to 5°C if potatoes are intended for table stock or seed. Potatoes intended for processing should be maintained preferably at 10°C and never should be subjected to temperatures below 5°C. It will be necessary to use a sprout inhibitor if potatoes are to be stored at 10°C for an extended period.

The relative humidity in the storage should be as high as possible without causing condensation of moisture on tubers and the storage structure. However, if soft rot is prevalent or if the tubers are wet when first put into storage, the humidity should be kept down until the tubers are dry.

RADISH

CULTIVARS
(Not Revised for 1992)

Main Crop	Jumbo	Bunching
Belle Glade	Champion	Revoso
Fuego	Red Crunchy	Saxafire
Red Cheriette	Scarlet Globe	Red Baron
Champion	Special	Galahand
Cherry Belle	Snow Belle (White)	

Cultivars or strains with globe-shaped roots entirely red in skin colour, and with leaves that are short to medium in length, are the most popular. Medium-top strains are preferable for early spring crops and short-top strains preferable during the longer day period.

Radish, a cool-season crop, is adversely affected by hot, dry weather, and remains in prime condition only a few days. To be mild, tender and attractive, it must be grown rapidly with plenty of moisture. If growth is checked the roots become hot, tough and pithy. Under medium- to short-day length, roots are normally well-shaped and tops relatively small. Under long days (15 hours) roots are misshaped, tops are long and usually produce seed stalks.

SEED TREATMENT

See Chemical Seed Treatment, page 30.

SEEDING AND SPACING

SEED — 11 to 17 kg per hectare. Use 22 to 34 kg/ha for machine harvesting.

SPACING — Rows 20 to 30 cm apart. Plants 40 to 50 per metre of row. For machine harvesting, space rows 10 to 15 cm apart.

SPRING CROP — The seed may be sown in the spring as soon as the soil is workable. Spring frosts, or even heavy snowfalls, after the plants have emerged, usually do not injure the crop seriously. Under **favourable** weather conditions radish seedlings appear above ground two or three days after sowing. Sowing at intervals in the spring will provide a continuous harvest.

SUMMER AND FALL CROP — Radishes are grown successfully on muck soils throughout the growing season because such soils are usually well supplied with moisture, and provide a cool growing medium. Only large-sized seed of the short- to medium-foliage cultivars or strains of radishes should be used.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **See tables on pages 27 and 28.**

NITROGEN — On MINERAL SOILS apply up to 60 kg N/ha. On MUCK SOILS apply 55 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

INSECT CONTROL

CABBAGE MAGGOT — Spray plants at or just after emergence.

1. [3]parathion
   (i) Parathion 15 WP 2.25 kg (15 days)

FLEA BEETLES — To limit the development of resistance, the insecticides listed below should be used **alternately.**

1. permethrin
   (i) Ambush 500 EC 140 mL (2 days)
2. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 (7 days)
3. malathion
   (i) Malathion 25 WP 2.25-5.5 kg (7 days)

APHIDS — Spray with:

1. diazinon
   (i) Diazinon 50 W 1.1 kg (10 days)
   (ii) Diazinon 500 EC 1.1 L (10 days)
   (iii) Basudin 500 EC 1.1 L (10 days)

[3]*Minimum period before re-entry is 7 days.*

RHUBARB

CULTIVARS
(Revised for 1992)

Outdoor	Forcing
Timperley Early	Victoria
Valentine	Sutton
Macdonald	
German Wine	
Sutton	

SPACING

Rows 75 cm apart, plants 75 cm apart in the row (17,220 plants per hectare). To produce roots for forcing, spacing in the field may be adjusted to 90 cm between rows and plants (11,950 plants per hectare) without any loss of yield or quality.

PLANT SELECTION

A number of virus and other diseases reduce the vigour of the plant and the yield, both in the field and in the forcing shed. Plants with vigorous growth should be marked during June and left in the field until the following spring, then dug up and used as planting stock. The remainder should be discarded.

FLOWER-STALK REMOVAL

Flower stalks should be cut out while they are still small, and in any case before the flowers open. This can conveniently be done at the same time as harvesting a crop for processing, but in crops grown for early fresh market, or for forcing, a separate operation will be necessary.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 280 kg N/ha for rhubarb to be forced, and only up to 200 kg/ha (split application) for field production.

APPLICATION — PREPLANTING — Plow under 45 to 90 tonnes/ha of manure in the fall. Broadcast and cultivate in 100 kg N/ha, with all of the phosphate and potash required, before planting.

ANNUALLY — Just before the buds break each spring apply 100 kg N/ha, with the phosphate and potash required (based on a soil test) as a broadcast dressing, or preferably as a side-dressing at a 10-cm depth. Immediately after pulling the crop for processing, apply broadcast 100 kg N/ha. Rhubarb to be forced should receive 180 kg of N/ha in July giving a total annual N requirement of 280 kg/ha.

IRRIGATION — As much as 100 kg N/ha may be applied through the irrigation system after pulling or in July for plants that are to be used for forcing.

DISEASE AND INSECT CONTROL

CROWN ROT AND VIRUS DISEASE (See Plant Selection) — Remove and destroy diseased plants. Only vigorous, normal plants should be used for propagation.

NEMATODES — **See page 32.**

POTATO STEM BORER — **Consult OMAF Factsheet, *Potato Stem Borer in Ontario*, Agdex 111/622.**

RHUBARB CURCULIO — Destroy dock weeds near the rhubarb planting.

Note: The use of gibberellic (Activol GA) is recommended for rhubarb forcing. Recommendations may be obtained from your Horticultural Crop Advisor.

RUTABAGA

For more details, **consult OMAF Factsheet, *Rutabagas (Table Turnips)*, Agdex 258/20.**

CULTIVARS
(Revised for 1992)

Laurentian (strains)

SEED TREATMENT

Buy Registered seed that has been treated with a seed-protectant such as thiram, captan, or streptomycin.

SEEDING AND SPACING

For the early crop (limited market) sow the seed when soil conditions allow seeding. The optimum soil temperature for germination is from 16 to 29°C. Sowings made after mid-June are more vulnerable to virus infection. Use up to 500 grams of seed per hectare. Plant to moisture, up to 1.5 cm deep.

Use seeders that space the seeds at known intervals, and use seed which has been precisely sized. This will eliminate or facilitate thinning and produce a highly uniform crop.

Where thinning is required, do so when plants are 4 to 8 cm high; space 15 cm apart in the row. Rows vary from 60 to 90 cm apart.

RUTABAGA (Continued)

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — Apply up to 35 kg N/ha. Manure may be used in the rotation at the rate of 18 to 22 t/ha but it should be applied at least a year before the rutabaga crop is grown. If manure is applied or legume sod is plowed down, reduce the nitrogen application. **(See tables on pages 17 and 19).**

SECONDARY AND MICRONUTRIENTS — BORON DEFICIENCY — Water-core or brown heart appears first in young, enlarging roots as firm, brownish, water-soaked patches. These may increase in size until almost the whole rutabaga root is affected. Severely affected rutabagas may turn punky inside later — after storage, rather than in the field. **Consult OMAF Factsheet, *Brown Heart in Rutabaga*, Agdex 258/690.**

BORON can be applied to the soil before sowing. The necessary quantity of boron can be mixed with the fertilizer which is applied before planting. Boron-enriched fertilizer should be applied as uniformly as possible.

Generally, foliar applications of Solubor are as effective as larger amounts applied to the soil. The first spray (foliar) application should be made when the roots of the plants are about 1.5 to 2.5 cm in diameter. The second and third applications may be applied at 10- to 14-day intervals after the first spray. Do not combine pesticides with boron sprays unless the label specifies compatibility. Excessive applications of boron will often adversely affect the succeeding crop in the rotation (e.g. soybeans, snap beans, white beans and small grains). For rates, **see page 26.**

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment. **Also see page 30.**

BLACK ROT AND BLACKLEG — Sow Registered seed. Do not plant rutabagas, rape, kale, cabbage, and other crucifers more than once in four or five years on the same land. Do not apply manure containing rutabaga refuse or diseased rutabagas on land intended for rutabagas. Do not work in the field when plants are wet. Never store diseased rutabagas. Clean out the storage each spring.

CLUB ROOT — Use a crop rotation with non-cruciferous crops. Avoid fields known to be infested. **See under CABBAGE, page 39.** (Note comment regarding calcitic lime).

MOSAIC VIRUS — Losses from turnip mosaic virus are especially heavy in plantings sown after mid-June. Volunteer rutabagas and winter rapeseed are the main overwintering sources of the virus. Aphids carry the virus to the rutabaga crop. Aphicides do not prevent the spread of the virus. For virus control recommendations, **consult OMAF Factsheet, *Turnip Mosaic Virus (TuMV) of Rutabaga*, Agdex 258/635.**

POWDERY MILDEW — This disease has recently become a serious problem in rutabagas, especially in southwestern Ontario. The cultivar 'Laurentian' is very susceptible to powdery mildew. The fungus spreads by means of conidia (spores) which are carried long distances by wind. Disease spread occurs rapidly during hot, dry weather. Control must be initiated at the first appearance of symptoms, i.e. white circular or star-shaped spots on older leaves and stems. Use:

1. sulphur
   (i) Micro-Niasul W 6.8 kg in 675-1125 L of water, depending on the stage of growth (0 days).

Thorough spray coverage of both upper and lower leaf surfaces is essential for powdery mildew suppression. This may require application at higher spray pressures than normally used. Apply Micro-Niasul weekly but **use no more than 5 applications per season.** This product is compatible with most commonly used insecticides but **not** with oil.

NEMATODES — **See page 32.**

INSECT CONTROL

ROOT MAGGOTS — Cabbage maggots overwinter as pupae in the soil in fields where they developed during the previous season. The adult flies emerge in early May and are present in 3 (occasionally 4) generations throughout the season. Practise crop rotation and plant early rutabagas as far as possible away from fields used for rutabagas or cole crops last year. Do not grow early and late rutabagas in the same field or near winter rapeseed or early broccoli, cabbage and cauliflower.

There are three periods of maggot damage related to the emergence of the 3 generations of flies: early in the season (prior to mid-June), during early July, and late in the season (after mid-August). Therefore, control of root maggots can be timed to coincide with the start of egg-laying activity of each generation of adults. In some areas, monitoring programs are carried out for cabbage maggot. Consult your Pest Management Advisor for timing of insecticide applications. Only a few insecticides are effective.

Each of these is highly toxic and applicators must take full safety precautions when using and storing these chemicals (see page 5). Safe disposal of empty bags and containers is equally important.

Treatment at Planting

Use one of the following granular insecticides in a 5-10 cm band at planting time only. Incorporate into the soil according to label instructions.

Group A (Carbamate)

1. carborfuran
   (i) Furadan 10 G 1.75 kg/1000 m of row.

Group B (Organo-Phosphate)

1. terbufos
   (i) Counter 15 G 1.5 kg/1000 m of row.
2. chlorpyrifos
   (i) Lorsban 15 G 0.6-1.0 kg/1000 m of row.

OR

Treatment After Planting

If no granular treatment is used at seeding, apply a drench spray using one of:

Group A (Carbamate)

1. [2]carbofuran
   (i) [2]Furadan 480 F 375 mL/100 L of water/1000 m of row (40 days). Apply in a 10 cm band over the row just prior to plant emergence.

RUTABAGA (Continued)

Group B (Organo-phosphate)
1. chlorpyrifos
   (i) Lorsban 4E 210 mL/125 L of water/1000 m of row (28 days). Apply on soil, 10 cm on each side of the plant 10 days after seeding.

Subsequent Treatments
Regardless of whether the granular or drench procedure is used for the first application, follow with drench sprays as follows **or** time applications according to emergence of second or third generation maggot flies. **Observe the days-to-harvest interval.** Use one of:

Group A (Carbamate)
1. [2]carbofuran
   (i) [2]Furadan 480 F 375 mL/100 L of water/1000 m of row (40 days). Apply in a 10 cm band over the row 5 weeks after seeding. Application may be repeated 5 weeks later (about mid-August).

   Note: There is no tolerance for residues of carbofuran on rutabagas sold in the United States. **For rutabagas to be exported to the U.S., carbofuran should be used only for the first drench treatment of the season.**

Group B (Organo-Phosphates)
1. chlorpyrifos*
   (i) Lorsban 4E 210 mL/125 L of water/1000 m of row (28 days). Apply on soil, 10 cm on each side of plants 28, 49 and 70 days after seeding.

   **Use no more than 4 applications per season.*
2. [2]azinphos-methyl
   (i) [2]Guthion Solupak 50 WP 375 g/200 L of water/1000 m of row (35 days). Apply in a 15 cm band over the row.
   (ii) [2]Guthion 240 SC 950 mL/200 L of water/1000 m of row. Apply in a 15 cm band over the row.

To limit the development of resistance, alternate whenever possible between insecticide Groups A and B above.

FLEA BEETLES — These insects can be controlled only in the adult beetle stage. There is no control for larvae established in roots. A spray should be applied as soon as the beetles appear in the field. Because beetles may migrate into the field over several weeks a number of applications may be required.

If insecticide drenches (carbofuran) are used to control root maggots, **flea beetles** may also be controlled. If drenches are not applied before seeding emergence and seedlings are attacked when they come up, or if beetles are numerous during the growing season, spray with one of the following materials. To limit the development of resistance, alternate between insecticide groups A, B and C for each application.

Group A (Carbamate)
1. carbaryl
   (i) Sevin XLR Plus 1.25-2.5 L (7 days)

Group B (Synthetic Pyrethroids)
1. permethrin
   (i) Ambush 500 EC 140 mL (before 8 leaf stage)
2. cypermethrin
   (i) Cymbush 250 EC 200 mL (21 days)

Group C (Chlorinated Hydrocarbons)
1. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)

   **Use no more than 2 applications per season.*

APHIDS — If the crop is threatened, spray with one of the following insecticides. These insecticides are not likely to be effective against aphids if combined with boron sprays.

1. oxydemeton-methyl
   (i) Metasystox-R 240 SC 1.75-2.25 L (14 days)
   (Use no more than 2 applications per season)
2. dimethoate
   (i) Cygon 480 E 0.7 L (7 days)
3. [1]parathion
   (i) [1]Parathion 800 EC 400-700 mL (15 days)
4. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)

   **Use no more than 2 applications per season.*

LEAF-EATING CATERPILLARS — If cabbageworms, cabbage loopers, zebra caterpillars, etc., are numerous, spray with one of:

1. Bacillus thuringiensis
   (i) Dipel 0.5-1.1 kg (0 days)
   (Use higher rates for looper control)
2. endosulfan*
   (i) Thiodan 4 EC 2.0 L (45 days)
   (ii) Endosulfan 400 EC 2.0 L (45 days)

   **Use no more than 2 applications per season.*

CUTWORMS **(See page 28)** — To control dark-sided cutworm, black cutworm, and red-backed cutworm use:

1. chlorpyrifos*
   (i) Lorsban 4E 1.2-2.4 L (30 days)
   (May be used at the rate of 2.4 L as a preplanting treatment)
   (ii) Lorsban 25 WP 1.125-2.25 kg (30 days)

   **Apply once at seedling stage (2-5 leaves), when damage first appears.*

---

[2]*Minimum period before re-entry is 48 hours.*
[1]*Minimum period before re-entry is 7 days.*

HARVESTING AND WASHING

Avoid bruising. Damaged and bruised rutabagas are likely to rot and do not store well.

Dirty water contains large numbers of rot-causing organisms. To reduce loss from disease after waxing, change water in the wash tank frequently or add fresh water continuously to keep water as clean as possible. Then spray-rinse rutabagas with clean water and dry them as rapidly as possible before waxing or shipping. Trimming after washing helps reduce rot in waxed rutabagas. Sodium hypochlorite in the rinse water has shown to be effective in reducing losses after waxing.

RUTABAGA (Continued)

STORAGE

Clean the storage thoroughly in the spring. To disinfect the storage, spray all surfaces with a mixture of copper sulfate (bluestone) 1 kg, hydrated lime 2 kg, dissolved in 50 litres of water. Add lime last. Since this mixture is corrosive to metals, cover metal fixtures such as fans, electrical control equipment, etc. during the spraying operation. An alternative disinfectant spray is a 1:240 solution of formaldehyde. **Follow all cautions.** Do not spread refuse from the storage on land that may be used for rutabagas.

Never put diseased rutabagas in storage. Disease-free rutabagas will keep up to 6 months if stored at 0°C and a relative humidity of 90 to 95%. Adequate ventilation and air movement throughout the storage are necessary.

Before feeding rutabaga tops or trimmings to livestock, check pesticide labels for warnings.

Do Not! . . . Feed Vegetables Treated with ENDOSULFAN to Livestock or Poultry

SPINACH

CULTIVARS
(Not Revised for 1992)

Mineral Soil	**Muck Soil**	
Long Standing Bloomsdale	(Tolerant to Bolting)	
(spring)	Wobli	1*
Tyee	Tarantella	3
(summer, fall)	Mazurka	1
Melody	Norveto	3
(summer, fall, overwintering)	Estivato	2
	Symphony	1
	Melody	2

**1 = smooth leaf; 2 = medium leaf; 3 = savoyed leaf.*

BOLTING

Spinach quickly bolts (produces flowerstalks) under long-day and warm-weather conditions. This explains why the crop is produced mostly in the spring or fall. Cool weather reduces the long-day effect. Spinach grown in cool summers may not bolt quickly.

Bolting may also be hereditary. Strains of spinach deteriorate in quality if the seed producer allows the quick-bolting types to increase.

SEED TREATMENT

Treat seed with a thiram or captan seed protectant.

SEEDING AND SPACING

Sow outside as soon as soil can be worked in early spring until early May, or from July 31 to August 31 for a fall crop. Do not sow seed in midsummer because bolting may occur. For over-wintered spinach, sow from September 1 to 10. About 12 kg of seed will plant one hectare.

Fresh seed will germinate readily at soil temperatures as low as 3 to 4°C, and good results are obtained at 10 to 16°C. At higher temperatures there is a more rapid emergence, but decreased percentage germination. The ability to germinate in cool soil permits very early sowing in spring.

Spinach seed more than a year old rarely germinates over 80%. Older seed is even less viable and germinates more slowly and irregularly.

Space rows 30 cm apart, and plants 5 to 10 cm in the row.

SOIL

Sandy soils are preferred for the early and over-wintered crops. The highest yields are obtained on muck soils. Muck soils have a high water-holding capacity, but are well-aerated. From such soils the harvested crop contains a minimum of sand or other gritty material. Since spinach is somewhat sensitive to soil acidity, a test should be made before planting the crop.

FERTILIZER

SOIL TESTS are required to determine phosphate and potash requirements. **(See tables on pages 27 and 28).**

NITROGEN — On MINERAL SOILS apply up to 110 kg N/ha. On MUCK SOILS apply 75 kg N/ha. If manure is applied or legume sod is plowed down reduce the nitrogen application. **(See tables on pages 17 and 19).**

APPLICATION — On MINERAL SOILS for a very early planting, all of the nitrogen may be applied at planting time.

For a midseason or later crop, apply half the recommended amount of nitrogen at planting time.

Side-dress the midseason or late crop with 55 kg N/ha following excessive rainfall, especially on sandy soils.

On MUCK SOILS, although the recommended amount of nitrogen should normally be considered maximum, it may be permissible following excessive rainfall to side-dress with an additional 55 kg N/ha.

DISEASE CONTROL

DAMPING-OFF — See Seed Treatment. **Also see page 30.**

DOWNY MILDEW AND MOSAIC — Grow a resistant cultivar. Do not grow a fall crop in, or adjacent to, a field where an infected spring crop was grown.

SPINACH (Continued)

FUSARIUM WILT AND ROOT ROT — In soils where this disease is a problem, do not seed spinach between May 31 and August 15.

NEMATODES — To avoid damage from sugar beet nematode, do not plant spinach following rhubarb, beets or spinach.

INSECT CONTROL

LEAF MINER — Spray when mines first appear. Use one of:

1. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 EC 350 mL (7 days)
2. malathion
   (i) Malathion 25 WP 5.5 kg (7 days)
   (ii) Malathion 500 EC 2.5 L (7 days)
3. diazinon
   (i) Diazinon 50 WP 1.1 kg (10 days)
   (ii) Diazinon 500 EC 1.1 L (10 days)
4. [2]azinphos-methyl
   (i) [2]Guthion Solupak 50 WP 0.9-1.1 kg (14 days)
   (ii) [2]Guthion 240 SC 1.8-2.2 L (14 days)

APHIDS — Use one of:

1. endosulfan*
   (i) Thiodan 50 WP 1.75 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   (iii) Thionex 50 WP 1.75 kg (14 days)
   **Make only one application*
2. diazinon
   (i) Diazinon 50 WP 1.1 kg (10 days)
   (ii) Diazinon 500 EC 1.1 L (10 days)
3. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 EC 225-375 mL (7 days)
4. dimethoate
   (i) Cygon 480 E 0.7 L (7 days)
5. naled
   (i) Dibrom 8 E 1.1 (4 days)
6. [2]azinphos-methyl
   (i) [2]Guthion Solupak 50 WP 0.9-1.1 kg (14 days)
   (ii) [2]Guthion 240 SC 1.8-2.2 L (14 days)

CABBAGE LOOPER — Use one of:

1. Bacillus thuringiensis
   (i) Thuricide HPC 4.5 L (0 days)
   (ii) Dipel WP 1.1 kg (0 days)
2. endosulfan*
   (i) Thiodan 50 WP 1.7 kg (14 days)
   (ii) Thiodan 4 EC 2.0 L (14 days)
   **Make only one application*
3. [3]parathion
   (i) [3]Parathion 15 WP 2.25 kg (7 days)
   (ii) [3]Parathion 960 EC 350 mL (7 days)
4. naled
   (i) Dibrom 8 E 1.1 L (4 days)

**Minimum period before re-entry is 7 days.*

TOMATO

CULTIVARS FOR CLIMATIC ZONES IN ONTARIO
(Revised for 1992)

FRESH MARKET	ZONES (See Figure 1, page 13)		HOME PROCESSING (PYO)
Cultivars (in approx. order of maturity	A,B,C,	C,D,E	**Cultivars** (order of maturity)
1. TH 318	—	X	1. TH 318
2. Pik Red	X	—	2. Bellstar
3. Sunrise	X	X	3. Ohio 7983
4. Pik Rite	X	—	4. FM 6203
5. Pilgrim	—	X	5. Veepick
6. Stokespak	—	X	6. Ohio 8245
7. Red Star *(trial)*	X	X	
8. Sunbeam *(trial)*	X	X	
9. Mountain Spring *(trial)*	X	X	
10. Market Pride *(trial)*	X	X	
11. Mountain Delight *(trial)*	—	X	

X Indicates suitability of cultivars in each zone.

CULTIVARS FOR COMMERCIAL PROCESSING:
Follow processors' requirements

CULTIVAR DESCRIPTIONS
Fresh Market

TH 318 — Early, compact open plant, variable fruit size. Additional nitrogen may be beneficial.

Pik Red — Early maturing, large slightly flattened globe fruit, green shoulder, requires good management of nitrogen and irrigation to prevent cracking. Prone to cracking and green shoulder in zone C.

Sunrise — Early maturing, very smooth globe-shaped fruit, high yielder, fruit size may be slightly small in drought conditions.

Pik Rite — Early midseason maturing, large globe fruit, green shoulder, requires good management of nitrogen and irrigation to prevent cracking. Prone to cracking and green shoulder in zone C.

Pilgrim *(trial)* — Early midseason, Verticillium resistant, uniform shoulder, good crack resistance, globe-shaped fruit, fruit size limiting under drought stress.

TOMATO (Continued)

Stokes Pak — Good flavour, somewhat softer than Sunrise and Pilgrim, otherwise all-round good quality. Susceptible to BER on droughty soils.

Red Star — Midseason maturity, very large, deep globe fruit, high yield potential and high quality in most cases, avoid excess application of nitrogen to reduce cracking.

Sunbeam — Midseason maturity, has a larger vine than Sunrise, good fruit size and contains the uniform ripening gene.

Market Pride — Late mid-season, good fruit size, uniform smooth fruit, good resistance to cracking.

Mountain Pride — Late maturity, very smooth fruit with good crack resistance, vigourous plant which may be suitable for staking.

Mountain Spring — Late midseason, approximately 5 days earlier than Mountain Pride, very smooth fruit with good crack resistance suitable for staking.

Home Processing

TH 318 — Early, compact open plant, variable fruit size.

Bellstar — Verticillium resistant. Early, pear-shaped, fairly large, firm fruit on a compact vine.

Ohio 7983 — Replaces Ohio 7814. Verticillium resistant, mid-season, medium-sized, plum-shaped fruit. Well-coloured and firm, excellent for wholepeel.

FM 6203 — Verticillium resistant, midseason, medium-sized square-round fruit with good firmness.

Veepick — Verticillium resistant, large pear-shaped fruit.

Ohio 8245 — Verticillium resistant; round firm fruit, good concentration of maturity, holds well in the field. Avoid excessive nitrogen applications as this may delay maturity and cause yellow shoulder.

SEED TREATMENT

Sow acid-treated seeds for bacterial canker disinfection or hot-water-treated seed **(page 30).** Treat dry seed with thiram seed protectant.

GROWING THE PLANTS

Since tomatoes require a relatively long growing season, they should be started in a greenhouse or hotbed. Sow seeds at a rate of 8 seeds per 25 mm at a depth of 6 mm in shallow flats about 8 weeks before field transplanting. A temperature of about 27°C for 1 to 2 weeks is required for good seed emergence.

When the seedlings are approximately 4 cm high or when the first true leaves appear, transplant them into other flats containing a fertile compost soil. The plants should be spaced 5 to 7 cm apart. Seedlings can also be transplanted into clay or peat pots or to veneer or paper bands.

Tomato plants can also be raised by sowing raw seed directly into peat pots, multi-pot trays, seedling flats or directly into beds filled with special growing media. Under such a planting system, usually a superior plant can be raised in a shorter time. This system is less labour intensive and reduces transplant shock.

Growing-media information can be obtained from OMAF Publication 365 or from your local Crop Advisor. Under no circumstances should large amounts of fresh manure or mushroom compost be added to a soil or soil-less mix as a dangerously high salt level in the growing medium will result in stunting, poor germination and death of young tomato plants. Where the salt level is in question, growing media should be analyzed prior to planting.

Tomato plants should be hardened for about one week before transplanting to the field. This can be accomplished by reducing the soil moisture supply, and reducing the air temperature to 13-16°C. Hardening-off improves the survivability of the plants to adverse weather conditions when field-set.

TRANSPLANTS

Fresh market tomatoes should be established from greenhouse-grown, container type transplants. Older transplants grown in larger containers such as 24 or 38 cell trays, will promote earlier maturity. Transplants for midseason or late maturing crops can be grown in smaller containers including 72, 128 or 200 cell trays. Smaller cells such as the 288 plug tray may be used but require more management.

Processing tomato crops may be established from southern bare-root or greenhouse grown plug transplants. Experience has shown that greenhouse-grown transplants are more reliable and have less potential for severe disease problems. The 288 cell tray is usually used for processing tomatoes although 406 plugs have been used successfully. Proper management of plug transplants is essential. Plug trays should be transported in a properly designed trailer and must be watered regularly to prevent the plug from drying out. Plugs should be moistened by dipping in water prior to transplanting to ensure that the plug does not dry out in the ground.

STORAGE OF PLUG TRANSPLANTS

If field planting is delayed by rain, plug transplants can be held for up to 2 weeks with very little reduction in plant stand or vigour. Store plug transplants by placing the racks of plants outside in an area which receives direct sunlight and which is sheltered from the wind. The racks should be elevated to prevent root growth through the bottom of the plugs. Do not store plants in an enclosed trailer or barn for more than one or two days, as this will result in very soft, elongated plants. Stored transplants should be watered regularly, and may require fertilization and a fungicide application if stored for longer than 5-7 days. Consult your crop advisor for recommendations.

STORAGE OF BARE ROOT TRANSPLANTS

Adverse weather conditions often disrupt field transplanting, forcing storage of crated southern transplants. The following storage practices will assist in maintaining a high plant-survival rate:

1. Open and check all crates to see that plants are dry and in good condition; remove mouldy bundles.
2. Store plants in sheltered areas (open sheds or barns); avoid hot, dry winds.
3. Keep foliage dry; do not sprinkle water on foliage while in storage.

TOMATO (Continued)

4. Avoid exposing the crates to temperatures above 10°-12°C.
5. Do not hold transplants longer than 10 days.

PLANT SPACING

Fresh market — Rows 1.2 to 1.5 m apart, 30 to 45 cm between plants.

Processing — HANDPICK; same as for fresh market, see above.

MACHINE HARVEST; large plant type varieties may be planted on single rows at a spacing of 1.5 to 1.65 m between rows (depending upon bed width) and 25 to 30 cm between plants. Most machine harvest type varieties will benefit from a twin-row planting arrangement. Twin rows should be spaced 45 cm apart, with 45 cm between plants within rows, on beds of 1.5 to 1.65 m centres. Wider beds (1.8 m centres) may make spraying and harvesting operations easier, but may reduce overall yield.

FERTILIZER

SOIL TESTS — should be used to determine phosphate and potash requirements. Phosphate and potash fertilizer should be applied as a broadcast application, prior to planting. On most soil types a fall-application of P and K is acceptable. **(See tables on pages 27 and 28).**

NITROGEN — *Fresh Market Tomatoes:* apply 35 to 50 kg/ha of actual N preplant, followed by a sidedress application 35 to 50 kg/ha actual N after the first fruit are set. Avoid late sidedress applications as this may prune roots and cause blossom-end-rot. If additional N is required late in the season it may be injected through the irrigation system.

Processing Tomatoes: the N rate will vary greatly, according to the variety, soil type, crop rotation, organic matter, and soil management. Apply N according to the following guidelines:

SOIL TYPE	CULTIVAR TYPE	
	HYBRID	OPEN-POLLINATED
Sands and sandy loams less than 2% organic matter.	130-150 kg/ha	80-100 kg/ha
Sandy loams and loams more than 2% organic matter.	80-100 kg/ha	50-80 kg/ha

Nitrogen should be applied as a pre-plant broadcast application. A **cover crop** should be seeded after harvest is completed; this will protect soil and reduce erosion. In addition, the soil will absorb and tie up nitrogen fertilizer, and reduce leaching.

STARTER SOLUTION (ALL TOMATOES) — Apply a high phosphorus starter fertilizer in the transplant water when transplanting tomatoes. Starter fertilizer is especially important when planting in cool soils in early spring. Starter fertilizers are available in several forms including 10-34-0 or 6-24-6 liquids or granular materials such as 10-30-20 or 10-52-10. Apply according to the following guidelines:

SOIL TEMPERATURE	STARTER CONCENTRATION*
Less than 18°C.	Use full label rate as recommended.
Between 18°-27°C.	Use half of recommended rate.
Greater than 27°C.	Starter not normally required.

**Use half recommended rates for sandy soils with less than 2% organic matter.*

PLASTICULTURE FOR FRESH MARKET TOMATOES

Will result in improved earliness, yield and quality of fresh market tomatoes. Plastic mulches warm the soil, conserve moisture and keep the fruit clean, thus reducing soil-borne fruit rots. Black plastic mulch is recommended because it also provides weed control. If plastic mulch is used, drip irrigation is recommended.

DISEASE CONTROL

A. IN THE SEEDBED

1. Sow acid-treated (preferred method) or hot-water-treated seed **(see page 30).**
2. Treat seed with thiram. See Seed Treatment.
3. Steam or fumigate soil with Vorlex, dazomet, or methyl bromide*.
4. Disinfect all greenhouse walls, benches and equipment.
5. Avoid unnecessary movement through the plants.
6. Immediately after sowing or transplanting, drench soil with captan 50 WP or 80 WP (see label).
7. When first true leaves develop, spray with one of the copper bactericides tank-mixed with either mancozeb or maneb at 11 g product per 50 m². Repeat spray every 7 to 10 days.

**A permit issued by the Ontario Ministry of the Environment is required to use methyl bromide.*

B. IN THE FIELD

BACTERIAL CANKER, BACTERIAL SPECK, BACTERIAL SPOT, SOUTHERN BACTERIAL WILT — It is not possible to control tomato bacterial diseases in the field with chemical sprays.

ANTHRACNOSE, EARLY BLIGHT, LATE BLIGHT — Spray when first fruits are about walnut size (or when first fruits appear on early cultivars). Repeat sprays as necessary. During continuous moist weather, intervals should be 5 to 7 days. In warm dry weather, intervals can be extended to 12 to 14 days if diseases are under control. For anthracnose, continue spraying until mid-September.

There are no practical control measures for tomato bacterial diseases after they are found in the field. Seed-borne bacterial canker can be prevented by soaking the seeds in hydrochloric acid **(see page 30)**, especially in transplants that are not clipped. Avoid working in tomato fields when the foliage is wet.

TOM-CAST is a program to help growers determine when to apply foliar fungicides in field tomatoes. It is designed for the control of Early Blight, Septoria Leaf Spot and fruit Anthracnose. A network of mini weather stations throughout the tomato growing regions of Ontario are used to monitor conditions favourable to disease development from which

TOMATO (Continued)

disease severity values are calculated for each day throughout the summer. Growers are advised to spray at critical values through agri-phone messages. Individuals interested in using or learning more about the system should contact their local Horticultural Crop Advisor or Pest Management Advisor.

Use one of:

1. chlorothalanil
   (i) Bravo 500 2.8-3.2 L (1 day) (Under heavy disease pressure, use higher rate).
2. mancozeb
   (i) Dithane M-45 3.25 kg (14 days)
   (ii) Manzate 200 3.25 kg (14 days)
3. maneb
   (i) Maneb 80 WP 3.25 kg (14 days)
   (ii) Dithane M22 3.25 kg (14 days)
4. metiram
   (i) Polyram 80 DF 3.25 kg (14 days)
5. benomyl
   (i) Benlate 50 WP 850 g (7 days)

SEPTORIA LEAF SPOT — Spray with:

1. chlorothalanil
   (i) Bravo 500 3.8 L (1 day)
2. anilizene
   (i) Dyrene 50 WP 2-3 kg (3 days)

FUSARIUM WILT, VERTICILLIUM WILT — Crop rotation is recommended. Grow Fusarium and Verticillium-wilt resistant cultivars if suited to area and market.

VIRUS DISEASE (MOSAIC, STREAK, GRAY WALL) — Grow seedlings in steamed soil in greenhouses and frames devoted to tomato seedlings only. Control aphids in seedbeds. Do not handle tobacco in any form when handling plants. Wash hands with soap and water before handling tomato plants. Do not harden transplants by leaving them in headlands or other weedy places. Cultivators should not be used in a healthy crop after use in an infected crop.

BLOSSOM-END ROT — Is a deficiency of calcium in the blossom end of the fruit which prevents proper development of that tissue. Drought conditions reduce the amount of water movement into the plant, thus reducing the movement of calcium to the fruit. Therefore, BER is caused primarily by drought, not by a deficiency of calcium in the soil. Sidedressing with calcium nitrate will not prevent BER if adequate moisture is not available. Foliar sprays of calcium are also not effective because most of the calcium is taken up and fixed in the leaves and very little reaches the fruit.

Under drought conditions, growers should avoid deep cultivation, which can prune roots and reduce moisture uptake and make BER more severe. Blossom-end-rot can be controlled by irrigation which allows more movement of calcium into the plant. *(See Irrigation, page 31).*

INSECT CONTROL

VARIEGATED CUTWORMS — Chemical control is obtained only when insects come in contact with the insecticide. Control is therefore related to how effective the spray coverage is on the larvae. Early detection and control are essential, as larger insects are more difficult to control.

Spray with one of:

1. permethrin
   (i) Ambush 500 EC 140 mL (1 day)
2. [1]methomyl
   (i) [1]Lannate L 1.1-2.25 L (1 day). If numerous large larvae (2.5-3.0 cm) are found, use higher rate.
3. carbaryl
   (i) Sevin XLR Plus 1.25 L (2 days)

FLEA BEETLES — Before field setting, spray with carbaryl 50 WP 60 grams or 85 WP 45 grams in 25 L of water. If a field spray is required, use one of the following in 1000 L of water:

1. carbaryl
   (i) Sevin XLR Plus 1.25 L (2 days)
2. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Endosulfan 400 EC 2.75 L (2 days)
3. permethrin
   (i) Ambush 500 EC 200 mL (1 day)
   (ii) Cymbush 250 EC 140 mL (3 days)
4. [2]azinphos-methyl
   (i) [2]Guthion 240 SC 2.25 L (2 days)
   (ii) [2]APM 50 WP 1.5 kg (2 days)
   (iii) [2]Azinphos-Methyl 240 EC 2.25-3.5 L (2 days)
   (iv) [2]Guthion Solupak 50 WP 1.1-1.75 L (2 days)

APHIDS — Control needed infrequently. Spray with one of:

1. diazinon
   (i) Diazinon 50 WP 1.0-1.75 kg (1 day)
   (ii) Diazinon 500 EC 1.1-2.0 L (1 day)
2. dimethoate
   (i) Cygon 480 E 550-700 mL (7 days)
3. malathion
   (i) Malathion 500 EC 1.25 L (3 days)
   Note: Not effective below 18°C.
4. endosulfan
   (i) Thiodan 50 WP 1.1 kg (2 days)
   (ii) Thiodan 4 EC 1.4 L (2 days)
   (iii) Thionex 50 WP 1.1 kg (2 days)
5. [1]methomyl
   (i) [1]Lannate L 1.25-2.25 L (1 day)
6. [2]azinphos-methyl
   (i) [2]Guthion Solupak 50 WP 1.1-1.75 L (2 days)
   (ii) [2]Guthion 240 SC 2.25-3.5 L (2 days)

Good spray coverage is required for aphid control. Repeated spray applications may be required when weather conditions favour rapid build-up of aphids. The two types of aphids affecting tomatoes are the potato aphid and the green peach aphid, the latter being more difficult to control.

TARNISHED PLANT BUGS — Dimethoate, when used to control aphids, will also give some control for tarnished plant bug.

COLORADO POTATO BEETLE — Regular field scouting provides accurate information on development and location of problem insect populations — increasing effectiveness of foliar sprays. For example, young Colorado potato beetle larvae are much easier to control than adult beetles. Border sprays may provide adequate protection of new tomato fields from migrating Colorado potato beetles.

TOMATO (Continued)

WARNING: In a number of counties and regions, Colorado potato beetles have developed at least 10 fold resitance to a number of insecticides. Refer to **page 69** in the Potato section for details and advice.

To control insecticide-susceptible Colorado potato beetles use one of the following insecticides and repeat as necessary. To slow development of further resistance it is essential for all growers to alternate insecticides, choosing from a different group each time a spray is applied.

Group A (Organo-Phosphates)

1. [2]azinphos-methyl
   - (i) [2]Guthion 240 SC 1.75 L (2 days)
   - (ii) [2]APM 50 WP 0.85 kg (2 days)
   - (iii) [2]Azinphos-Methyl 240 EC 1.7 L (2 days)
   - (iv) [2]Guthion Solupak 50 WP 850 g (2 days)

Group B (Synthetic Pyrethroids)

2. permethrin
   - (i) Cymbush 250 EC 140 mL (3 days)
   - (ii) Ambush 500 EC 200 mL (1 day)

Group C (Carbamate)

3. carbaryl
   - (i) Sevin XLR Plus 1.25 L (2 days)

Group D (Bacterial)

4. Bacillus thuringiensis
   - (i) M-One 5.0-9.0 L (1 day) (for small larvae only)

HORNWORMS — If hornworms are present, spray with one of:

1. permethrin
   - (i) Ambush 500 EC 200 mL (1 day)
2. carbaryl
   - (i) Sevin XLR Plus 2.5-5.25 L (2 days)
3. endosulfan
   - (i) Thiodan 50 WP 1.1 kg (2 days)
   - (ii) Thiodan 4 EC 1.4 L (2 days)
   - (iii) Thionex 50 WP 1.1 kg (2 days)
4. Bacillus thuringiensis
   - (i) Thuricide HPC 725 mL — 1.5 L (0 days)
   - (ii) Dipel WP 275-550 g (0 days)
5. [2]azinphos-methyl
   - (i) [2]Guthion 240 SC 1.75-2.25 L (2 days)
   - (ii) [2]APM 50 WP 0.85 kg (2 days)
   - (iii) [2]Azinphos-Methyl 240 EC 1.7-2.2 L (2 days)
   - (iv) [2]Guthion Solupak 50 WP 850 g (2 days)
6. naled
   - (i) Dibrom 8 E 1.1 L (4 days)

DROSOPHILA (fruit fly) — In the field — apply one of:

1. diazinon
   - (i) Diazinon 50 WP 1.75 kg (1 day)
2. naled
   - (i) Dibrom 8 E 1.1 L (4 days)
3. [2]azinphos-methyl
   - (i) [2]Guthion 240 SC 2.25 L (2 days)
   - (ii) [2]APM 50 WP 0.85 kg (2 days)
   - (iii) [2]Azinphos-Methyl 240 EC 1.7-2.2 L (2 days)
   - (iv) [2]Guthion Solupak 50 WP 850 g (2 days)

Picked fruit — Spray or dust fruit and containers with a commercial mixture containing pyrethrins and piperonyl butoxide at rates given on the label. This spray or dust is permitted on all types of tomatoes.

CABBAGE LOOPERS — If cabbage loopers are a problem spray with:

1. Bacillus thuringiensis (most effective against small larvae)
   - (i) Thuricide HPC 4.25 L (0 days)
   - (ii) Dipel WP 1.1 kg (0 days)

SAP BEETLES — Since there is no suitable insecticide to control sap beetles in the field, practise the following cultural controls to reduce the incidence of sap beetles in the fruit:

1. Leave roadways in the field at suitable intervals to allow movement of farm vehicles without squashing fruit.
2. Minimize crushing and squashing of fruit at picking time.
3. Pick as close as possible to time of delivery to the factory.
4. If loaded wagons are not delivered immediately, leave them exposed to air circulation rather than in a protected area.

GRASSHOPPERS AND CRICKETS — Maintain weed-free borders and fencerows. If these insects are a problem spray around the edge of the field with:

1. [2]azinphos-methyl
   - (i) [2]Guthion 240 SC 2.25 L (2 days).

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[1]*Minimum period before re-entry is 24 hours.*
[2]*Minimum period before re-entry is 48 hours.*

RING-BILLED GULL CONTROL

Ring-billed gull populations are increasing and are moving further inland along the shores of Lake Erie and Ontario. Tomato fruits are damaged by repeated feeding scars resulting in reduced yields and quality, and increased sorting costs. Overall population control is not feasible; however, growers wishing to protect areas within a field can obtain a licence to shoot gulls. Early gull detection and control are important. For a permit, call the Enforcement Co-ordinator, Canadian Wildlife Service, Ontario Region, 152 Newbold Court, London, Ontario. **(519) 681-0486.**

CHEMICAL FRUIT RIPENING

Use ethephon (Ethrel) for uniform ripening and once-over harvest and to enhance ripening in the late cultivars or during late seasons. For best results ethephon should be applied to fields in good condition; plants which are stressed (wilted or damaged by disease or insects) will not respond satisfactorily.

Ethephon is effective only on fruits that are mature green (i.e. when cutting fruit with a sharp knife, seeds should remain uninjured, protected by a gelatinous pulp). With most processing cultivars the time of application is when the maximum number of fruit has reached the mature green stage; this occurs when 5 to 20% of the fruit is showing red **colour** development. Good spray coverage on fruit and foliage is essential for maximum effectiveness. Use 3.75 to 7.50 L in 500 to 1000 L of water per hectare. Use higher rates when day temperatures are below 18°C and also when plant growth is dense. If plants are under stress, avoid use of ethephon or apply it at reduced rates. Excessive rates of ethephon will cause defoliation which will result in reduced fruit quality. Cool temperatures will delay colour development, and extend period between treatment and harvest. Generally, fruit is ready to harvest 14 to 21 days after treatment.

Ethrel is not registered for use on fresh market tomatoes!

PUBLICATIONS FOR VEGETABLE GROWERS

MINISTRY OF AGRICULTURE AND FOOD PUBLICATIONS

Publications available from Consumer Information Centre, 801 Bay St., Ontario Ministry of Agriculture and Food, Toronto, Ontario M7A 2B2 or from the Horticultural Crop Advisor or Pest Management Advisor serving your area.

No.	NUMBERED PUBLICATIONS
40	*Greenhouses
63	*Farm Roadside Marketing in Ontario
73	Handbook of Drainage Principles
75	Guide to Weed Control
365	Greenhouse Vegetable Production Recommendations
485	Growing Vegetable Transplants
486	Onions
501	*Farm Drainage
502	*Rutabagas
505	*Ontario Weeds $5.00
515	*Farm Ponds
534	Potato Production in Ontario
—	Catalogue of Plans for Fruit and Vegetable Buildings and Equipment

AGDEX	FACTSHEETS
111/31	*Heat Units for Corn in Southern Ontario
111/542	Nitrogen Fertilizer Materials
111/622	Corn Rootworms
111/622	Potato Stem Borer in Ontario
111/632	*Head Smut of Corn
111/685	*Bird Damage to Corn
140/10	Coloured Beans in Ontario
141/628	The Soybean Cyst Nematode
161/2[illegible]	*Cultural Practices for Potatoes
161/25	*Potato Quality
161/33	*Potato Varieties
161/635	Black Scurf and Silver Scurf of Potatoes
161/635	*Dry Rots of Potatoes in Storage
161/635	Ring Rot of Potato
161/745	Reducing Mechanical Injury in Potato Handling
181/630	Tobacco Veinal Necrosis Strain of Potato Virus Y
200/545	*Metal Chelates in Horticulture
200/628	Land Preparation: A Key to Successful Soil Fumigation
200/691	*Air Pollution and Horticulture Crops
202/51	Pick-Your-Own Harvesting
202/65	Storage Incompatibility
202/736	*Humidity in Refrigerated Storages for Fruit & Vegetables
210/744	*Application Technique with Air-Blast Sprayers
250/13	*Yields of Vegetable Crops
250/22	*High-Density Planting of Vegetable Crops
250/22	Growing Vegetable Transplants in Plug Trays
250/24	*Polyethylene Mulches in Vegetable Crops
250/52	*Picking Aids for Vegetable Crops
250/60	Home Storage of Vegetables
250/65	*Sprout Inhibition of Stored Vegetables
250/541	*Starter Solutions for Vegetable Crops
250/560	Irrigation of Vegetable Crops
250/612	Thrips on Onions and Cabbage
251/635	Fusarium Yellows of Celery
252	Storage of Cabbage
252/20	Chinese Cabbage Production in Southern Ontario
252/20	Production and Handling of Broccoli
252/64	*Storage of Cabbage
252/612	*Cabbage Loopers
252/625	*Cabbageworm
252/635	Bacterial Diseases of Cruciferous Crops
252/635	*Bacterial Leaf Spot of Cauliflower
252/635	Fungal Diseases of Cruciferous Crops
252/690	*Hollow Stem in Broccoli
253/732	*Storing & Using Sweet Corn Cannery Waste
253/22	Scheduled Planting of Sweet Corn
253/30	High Sugar Sweet Corn
254/13	*Commercial Asparagus Production
254/13	Growing Rhubarb
254/18	*Rhubarb Forcing
254/21	*Field Rhubarb for Processing
254/22	Asparagus: Establishing the Plantation
254/22	Asparagus: Maintaining the Plantation
254/57	Maintaining Asparagus Quality from Producer to Consumer
254/625	Insect Pests of Asparagus
254/635	Diseases of Asparagus
255/20	Peas for Processing
255/630	*Fungal Diseases of Field and Snap Beans
256/07	*Sex Expression in Cucumbers
256/20	Growing Pickling Cucumbers
256/20	Muskmelon Production
256/26	Pollination of Vine Crops
256/51	Mechanical Harvesting of Cucumbers
256/635	*Angular Leaf-Spot of Cucumbers
256/821	Mechanical Harvesting of Pickling Cucumbers-Economic Aspects
257/13	Atlantic, Norchip and Monoma Potatoes
257/13	Conestoga and Superior Potatoes
257/13	*Jemseg Potato
257/13	Shepody Potato
257/13	Yukon Gold Potato
257/20	Pepper Production
257/21	*Production of Potatoes for Processing
257/22	Field Seeding of Tomatoes
257/25	Tomato Fruit Diseases
257/25	*Tomato Colour Defects
257/25	Potato Quality
257/28	Growing Potatoes from True Potato Seed
257/560	Irrigation Scheduling for Tomatoes — Water Budget
257/620	Greenhouse Vegetable Seedling: Protocol for Managing Thrips and the Tomato Spotted Wilt Virus
257/635	*Bacterial Speck of Tomato
257/635	*Black Heart and Jelly End-Rot of Potatoes
257/745	Reducing Mechanical Injury in Potato Handling
258/13	*Baby Carrot Production
258/13	Commercial Parsnip Production in Ontario
258/13	Garlic
258/13	Garlic Production
258/13	*Horseradish

Factsheets (Continued)

258/20	Rutabagas
258/20	Sweet Potatoes (162/20 Sweet Potatoes)
258/20	Leek Production
258/55	*Onion Drying
258/64	Storage of Carrots
258/64	Storage Rutabagas
258/605	Carrot Insects
258/605	*Onion Maggot Control on Dry Onions
258/635	Field Diseases of Onions
258/635	Onion Neck Rot
258/635	Phoma Canker of Parsnip
258/635	Turnip Mosaic Virus (TuMV) of Rutabaga
258/635	*Virus Disease of Rutabagas (Turnips)
258/635	Weather-Timed Sprays for Carrot Blight Control
258/690	Brown Heart in Rutabaga
261/10	Growing Mushrooms
263/14	Herb Gardening
290/620	Two Serpentine Leafminers Attacking Vegetables & Orn's
570/740	Coulters and Presswheels
070	Public & Farm Weather Forecasting & Terminology
072	Freeze Risk During Spring and Autumn in Ontario
510	Soil Compaction
512	*Management of Organic Soils
524	Soil Capability Classification for Agriculture (CLI)
534	*Soil Acidity and Liming
537	Cover Crops in Conservation Farming
540	Chemical & Organic Fertilizers
540	Fertilizer Management in Conservation Tillage Systems P&K
542	Safe Placement of Fertilizers
553	*Maintenance of the Drainage System
555	Drainage Benefits
562	*Irrigation Water Supply
572	Soil Erosion-Causes and Effects
572	Planting and Maintening Field Windbreaks
573	Grassed Waterways
573	Strip Cropping for Water Erosion Control
607	Farm Storage of Pesticides
607	Safe Use of Granular Pesticides
607	Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure
607	Management of Pesticides on the Farm
607	Pesticide Container Rinsing
607	Pesticide Contamination of Farm Water Supplies
607	Protective Clothing When Using Horticultural Pesticides in Greenhouses
607	Protective Clothing When Using Pesticides Outdoors
607	Reducing Pesticide Drift and Crop Damage
610	Slugs
616	Honeybees for Pollination of Crops
616	*Winter Protection of Bees
616	*Package Bees
616	*Moving Bees
616	*Handling Cappings Wax From Honey Combs
616	*Feeding Honey Bees
616	*Beekeeping — Northern Ontario
616	*Beekeeping — General Information
616	Pollination for Fruit & Seed Production
628	Soil and Root Sampling for Nematode Analysis
640	The Perrennial Ground Cherries
647	Poison-Ivy
675	*Earwigs
675	Sap Beetles on Raspberries, Tomatoes, Corn
707	*Homemade Hygrometers
707	*Measuring Relative Humidity (RH)
744	Field Sprayer Calibration

AGRICULTURE CANADA PUBLICATIONS

868	Manures and Compost
1058	Potatoes
1083	Soil Erosion by Water
1158	Growing Savory Herbs
1266	Soil Erosion by Wind
1337	How to Build a Plastic Crop Shelter or Greenhouse
1355	Growing Rutabagas
1479	Tomato Diseases
1482	Field Sprayers
1492	Diseases and Pests of Potatoes
1508	Bulk Potato Storage
1558	Growing Garden Tomatoes
1559	Growing Garden Potatoes
1624	Rhubarb Culture
1681	Composting
1684	Cucumber Diseases

Indicates publication out-of-print **although County offices may have a supply on hand.*

ABBREVIATIONS

EC	=	emulsifiable concentrate	g	=	gram
WP	=	wettable powder	m	=	metre
F	=	flowable	cm	=	centimetre
E	=	emulsion	ha	=	hectare
SC	=	spray concentrate	mL	=	millilitre
SP	=	soluble powder	t	=	tonne
G	=	granules or granular	kg	=	kilogram
°C	=	degrees Celsius	km	=	kilometre
AP	=	agricultural powder	mm	=	millimetre
W	=	wettable (powder)	L	=	litre
L	=	liquid	hL	=	hectolitre
LC	=	liquid concentrate	kPa	=	kilopascal

METRIC INFORMATION

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic metre (m^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight — Volume Equivalents (for water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry — Liquid Equivalents

1 cm^3 = mL
1 m^3 = 1000L

APPLICATION-RATE CONVERSIONS

(approximate)

Metric to Imperial (Approximate)

litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23	=	litres per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

Dry-Weight Equivalents

Grams or Kilograms per Hectare		Approximate Ounces or Pounds per Acre
100 grams	=	1½ ounces
200 grams	=	3 ounces
300 grams	=	4¼ ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1¼ pounds
2.00 kilograms	=	1¾ pounds
2.50 kilograms	=	2¼ pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3½ pounds
5.00 kilograms	=	4½ pounds
6.00 kilograms	=	5¼ pounds
7.50 kilograms	=	6¾ pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11½ pounds
15.00 kilograms	=	13½ pounds

Liquid Equivalents

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

CONVERSION TABLE — METRIC TO IMPERIAL
(approximate)

Length

1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre	=	0.62 mile

Area

1 square centimetre (cm^2)	=	0.16 square inch
1 square metre (m^2)	=	10.77 square feet
1 square metre (m^2)	=	1.20 square yards
1 square kilometre (km^2)	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (liquid)

1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imperial)
1 litre (L)	=	0.26 gallon (U.S.)

Volume (dry)

1 cubic centimetre (cm^3)	=	0.061 cubic inch
1 cubic metre (m^3)	=	1.31 cubic yards
1 cubic metre (m^3)	=	35.31 cubic feet
1000 cubic metres (m^3)	=	0.81 acre-foot
1 hectolitre (hL)	=	2.8 bushels

Weight

1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2205 pounds

Speed

1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Pressure

1 kilopascal (kPa)	=	0.15 pounds/square inch

Temperature

$°F = (°C \times 9/5) + 32$

$°C = (°F-32) \times 5/9$

CONVERSION TABLE — IMPERIAL TO METRIC
(approximate)

Length

inch	=	2.54 cm
foot	=	0.30 m
yard	=	0.91 m
mile	=	1.61 km

Area

square foot	=	0.09 m^2
square yard	=	0.84 m^2
acre	=	0.40 ha

Weight

ounce	=	28.35 g
pound	=	453.6 g
ton	=	0.91 tonne

Pressure

pound per square inch	=	6.90 kPa

Volume (dry)

cubic yard	=	0.76 m^3
bushel	=	36.37 L

Volume (liquid)

fluid ounce (Imp.)	=	28.41 mL
pin (Imp.)	=	0.57 L
gallon (Imp.)	=	4.55 L
gallon (U.S.)	=	3.79 L

Temperature

$°F = (°C \times 9/5) + 32$

$°C = (°F - 32) \times 5/9$

EMERGENCY AND FIRST-AID PROCEDURE FOR PESTICIDE POISONING

Become familiar with the chemicals you are using. Keep a list of common names in case of accidents or emergencies. This information can be found on the product labels and cross-referenced in this publication.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing, and wash the skin thoroughly with soap and warm water. Repeat the wash.

If a pesticide has come in contact with the eyes, rinse them with plenty of clean water for 15 minutes.

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL. TAKE THE LIST OF CHEMICAL COMMON NAMES WITH YOU AND IDENTIFY THE ONES BEING USED. IF A PERSON IS FOUND UNCONSCIOUS OR LAPSES INTO UNCONSCIOUSNESS, CALL AN AMBULANCE IMMEDIATELY!

Emergency advice on pesticide poisoning is available by contacting the Poison Information Centres: The names and telephone numbers are listed under Emergency Calls at the front of each Bell telephone directory.

FILL IN THE FOLLOWING:

MY LOCAL POISON INFORMATION CENTRE TELEPHONE NUMBER IS: _____

POISON CONTROL CENTRES IN ONTARIO

Barrie
Royal Victoria Hospital
Dr. Raymond Alquist
Emergency Department
(705) 728-9802

Belleville
Belleville General Hospital
Dr. James E. Nelles
Emergency Department
(613) 968-5511

Brantford
Brantford General Hospital
Dr. C.H. Pickett
(519) 752-7871

Burlington
Joseph Brant Memorial Hospital
Dr. D. Raes
(416) 632-3730

Chatham
St. Joseph's Hospital
Emergency Department
(519) 352-2500

Guelph
St. Joseph's Hospital
Dr. J.J. Brown
(519) 824-2620

Kingston
Kingston General Hospital
Dr. Murray Taylor
(613) 547-2121

Kirkland Lake
Kirkland and District Hospital
Director
(705) 567-5251

Kitchener
Kitchener-Waterloo Hospital
Dr. Swan
(519) 742-3611

St. Mary's General Hospital
Dr. W.H. Friday
(519) 744-3311

London
Victoria Hospital
Emergency Department
(519) 432-5241

Ottawa
Children's Hospital
Emergency Department
(613) 521-4040

Ottawa General Hospital
Emergency Department
(613) 231-2121

Picton
Prince Edward County
Memorial Hospital
Emergency Department
(613) 476-2181

St. Catharines
St. Catharines General Hospital
Dr. W.G. Sollich
Emergency Department
(416) 684-7271

Sarnia
Sarnia General Hospital
Dr. K.R. Singh
Emergency Department
(519) 344-3661

St. Joseph's Hospital
Emergency Department
(519) 336-6121

Sault Ste. Marie
Plummer Memorial
Public Hospital
Dr. W.J. Robertson
Emergency Department
(705) 254-5161

Simcoe
Norfolk General Hospital
Dr. K.R. McGavin
(519) 426-0750

Sudbury
Sudbury General Hospital
Dr. E.S. Lapchinski
(705) 674-3181

Thunder Bay
McKellar General Hospital
Dr. P.C. McGillivray
(807) 623-5561

Port Arthur General Hospital
Dr. Amot R. Hawkins
(807) 344-6621

Toronto
Toronto East General and
Orthopedic Hospital
Dr. A. Kaminker
(416) 461-8272

Hospital for Sick Children
Dr. Raymond Ng
(416) 597-1500

Windsor
Hotel Dieu de St. Joseph
Dr. W. Gatfield
Emergency Department
(519) 252-3631